LEXICAL STRESS SENSITIVITY AND READING IN ENGLISH: A SYSTEMATIC REVIEW AND TWO EMPIRICAL EXPLORATIONS AMONG KOREAN-ENGLISH BILINGUALS

A Dissertation

by

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ABSTRACT

The present dissertation explores the relationship between lexical stress and reading in English. The dissertation comprises three studies: one systematic review and two empirical studies. Study 1 aims to disentangle the relationship between English lexical stress and reading by systematically reviewing the empirical studies published in the last 20 years. Study 2 examines Korean-English bilingual adults' (N = 41) sensitivity to different cues to stress assignment during multisyllabic nonword reading in English, and its contribution to reading. Last, Study 3 investigates 3rd to 5th grade Korean-English bilingual children's (N = 39) stress cue sensitivity, and its relationship with reading ability in English.

In the systematic review, 20 studies comprised the final sample for coding based on inclusion/exclusion criteria. Overall, the study showed that lexical stress sensitivity is significantly associated with word reading in English. The findings further demonstrated some ambiguities in using different measures for stress sensitivity. The empirical studies focused on two major cues to stress assignment in English: (1) Orthographic cues which refer to probabilistic information of particular word endings that are associated with stress patterns and (2) morphological cues which refer to English derivational suffixes that provide information for stress assignment. The empirical studies also explored the contribution of stress cue sensitivity to English reading ability among two groups of Korean-English bilinguals. Study 2 revealed that Korean-English bilingual adults relied on both stress cues, and no statistically significant differences were found between the cues. Study 2 confirmed that the bilingual adults' stress cue sensitivity was related to their English reading. Study 3 also showed that Korean-English bilingual children were sensitive to the two stress cues with better performance on the

orthographic cues to stress assignment task than the morphological cues task. However, no significant correlations were found among the bilingual children's stress cue sensitivity measures and reading performances.

Taken together, the present dissertation emphasizes the importance of stress sensitivity and its relationship with reading in English. The empirical studies contributed to the scarce literature on stress processing among the bilingual population. The dissertation also discusses research and pedagogical implications of stress sensitivity and reading in English.

DEDICATION

To my sweet daughter, Claire Soyun Lee,

To my dear son, David Jemin Lee,

To my wonderful husband, Seung Jun Lee,

To my beloved parents, Y.H. Moon & J.C. Park,

For all their love, support, and sacrifice

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It is hard to believe that I am finally writing the acknowledgments for my dissertation. Looking back the last five years, juggling my multiple roles—as doctoral student, mother, and wife etc.—has not always been easy. I started the program when David just turned 3 and Claire was not even 5 months old. Right after the preliminary exam, I had to move from Texas to California where I had to do all the data collection and writing away from the campus. There have been moments when I doubted myself. However, all this has been possible thanks to so many individuals who have given me continuous support throughout this journey.

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This work was supervised by a dissertation committee consisting of Professor L. Quentin Dixon (advisor) and Professor Li-Jen Kuo (co-advisor) of the Department of Teaching, Learning, and Culture, Professor Jyotsna Vaid of the Department of Psychological and Brain Sciences, and Professor Wen Luo of the Department of Educational Psychology. All work for the dissertation was completed independently by the student.

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CHAPTER I

INTRODUCTION

In the past several decades, there has been a consistent consensus that phonological processing, in particular phonological awareness—defined as "the ability to reflect upon and manipulate phonological units in a language" (Kuo & Anderson, 2008, p. 42)—is one of the strongest predictors of early reading development (e.g., Cain, 2010; Goswami & Bryant, 1990) as well as of reading difficulties (e.g., Cain, 2010; Ramus et al., 2003). Moreover, cross-language research has also reported a strong association between phonological awareness and early reading development among bilingual readers across different orthographies (e.g., Bialystok, 2002; Dixon, 2010).

Nevertheless, it should be noted that the *phonological units* as described in the widely accepted definition of phonological awareness has focused almost exclusively on *segmental* phonology (e.g., phonological *segments* such as syllable, rime, and phoneme) often within a monosyllabic word (Holliman, 2016; Wade-Woolley & Heggie, 2016). Thus, the other type of phonology—*suprasegmental* phonology (e.g., prosodic features such as intonation, stress, and timing)—has been left neglected in the established literature of phonological awareness until recently (Holliman, 2016; Veenendaal, Groen, & Verhoeven, 2016; Wang & Arciuli, 2015). In a similar vein, a majority of studies on word recognition have also focused on transferring of orthography to phonemes or decoding at the level of segmental phonology (e.g., Koda, 1996).

In the last 15 years in particular, the literature has been growing rapidly on the contributions of suprasegmental phonology or prosodic awareness to literacy development (e.g., Clin, Wade-Woolley, & Heggie, 2009; Holliman, Wood, & Sheehy, 2008; Whalley & Hansen,

2006; Wood, Wade-Woolley, & Holliman, 2009). Accumulating empirical evidence (e.g., Mundy & Carroll, 2016; Wade-Woolly & Heggie, 2016) as well as recent attempts to integrate such findings into a single model of reading confirms that suprasegmental processing contributes to literacy development in several possible ways—via phonological awareness, morphological awareness, and vocabulary—or even uniquely (e.g., Holliman et al., 2014a; Kim & Petscher, 2015; Wood et al., 2009). Similarly, researchers in the field of computational models of reading have begun to move beyond the monosyllabic word reading and to consider stress assignment in multisyllabic word reading in developing theoretical models for reading (e.g., Mousikou, Sadat, Lucas, & Rastle, 2017; Perry, Ziegler, & Zorzi, 2010; Ševa, Monaghan, & Arciuli, 2009).

Despite a burgeoning literature on suprasegmental phonology and reading, some major research gaps still exist. First, not many studies have been conducted among bilingual speaker groups who are exposed to two different prosodic systems. In particular, few studies have investigated Korean-English bilingual groups whose two prosodic systems of first language (L1) and the second language (L2) differ vastly. Moreover, given that research in this area has been conducted in different fields of studies with distinct purposes and methods (Wang & Arciuli, 2015), it is important to clarify the differences and similarities and further to discover and investigate the potential for crossover among the different research streams.

Significance of My Studies

Of timely and critical importance, the present dissertation aimed to explore the relationship between lexical stress and reading in English. My dissertation consists of three studies: one systematic literature review and two empirical studies. First, the literature review provides a general overview of the extant empirical studies that discuss the role of stress sensitivity in word reading development. This review aims to disentangle the relationship

between stress sensitivity and reading development in English. Second, the first empirical study focuses on Korean-English bilingual adults' sensitivity to different cues—orthographic cues and morphological cues—to stress assignment during multisyllabic nonword reading in English. The second empirical study examines Korean-English bilingual children's stress sensitivity to different cues to stress assignment, and its contribution to their reading ability in English.

With these three studies, I attempted to fill some important research gaps in the field of suprasegmental processing and reading development with a focus on English stress sensitivity. Given the rapidly increasing number of empirical studies, the systematic literature review provides an up-to-date and thorough understanding of the extant studies in the field and, further, lays a foundation for future investigations to disentangle the prosody-literacy relationships. A careful review of different measures used to assess stress sensitivity and the relationship with reading would also be useful for future researchers in the field as well as practitioners with diagnostic purposes.

In addition, the participants of the two empirical studies included the understudied population of Korean-English bilinguals whose prosodic system of L1 (Korean) differs greatly from that of L2 (English). The two studies contribute to the scarce literature on suprasegmental processing among bilingual readers by casting interesting open empirical questions of how sensitive these bilinguals are to English stress patterns, whether the bilinguals' stress sensitivity contributes to their reading ability, and whether their L1 prosodic system affects their L2 stress sensitivity. Furthermore, the inclusion of both adult and child groups of Korean-English bilinguals in two separate studies will further broaden our understanding of the population. For example, Korean-English adults represent sequential bilinguals or skilled L2 readers whereas

Korean-English children would represent simultaneous bilinguals or relatively beginning readers in their primary schools.

Studies on stress sensitivity provide both research and practical implications. Theoretical frameworks of existing reading theories and computational reading models may benefit from potential empirical evidence on the contribution of stress sensitivity or processing to reading. Additionally, appropriate instruction or intervention can be provided to the bilingual readers by considering their L1 and L2 prosodic systems. As Wang and Arciuli (2015) mentioned, the particular topic of my dissertation can be a crucial piece of a jigsaw that can provide insights to different research streams of suprasegmental information to reading.

A Note on the Use of Terminology

Admittedly, many of the terms such as *stress*, *prosody*, and *suprasegmental* have been used interchangeably in a majority of literature in combination with *sensitivity* and *awareness* (e.g., stress sensitivity, prosodic sensitivity, and stress awareness). Although the intent is not to define the terms with precise definitions for distinction, it will be worth taking a moment to discuss some underlying differences in nuances that may be helpful in reviewing the literature.

Generally speaking, as the broadest overarching term, *suprasegmentals* refers to "the acoustic, physical properties of the speech stream" that can be applied *across* individual segments, words, and phrases (Clin et al., 2009; Thomson & Jarmulowicz, 2016, p.viii). From a perspective of phonetic production, those acoustic and physical properties of the speech stream include intensity, fundamental frequency, and duration of the signal (Shriberg & Kent, 2003), which are perceived as variations in loudness, pitch, and timing, respectively (Holliman, 2016; Thomson & Jarmulowicz, 2016). These suprasegmental features may carry prosodic and paralinguistic information (Thomson & Jarmulowicz, 2016).

Prosody, which has often replaced the term suprasegmentals, can be defined as "the phonological subsystem that encompasses the tempo, rhythm and stress of language" (Whalley & Hansen, 2006, p. 288), "the stress and intonation patterns of a language" (Clin et al., 2009, p. 198), or "the rhythmic patterning of spoken language" (Holliman, Wood, & Sheehy, 2014b, p. 256). Three major aspects of prosody are stress, timing, and intonation, which are manifested through variations in suprasegmental features such as loudness or intensity, length or duration, and pitch or fundamental frequency (Holliman et al., 2014b; Kim & Petscher, 2015; Whalley & Hansen, 2006). Prosody has various functions: linguistic, affective, and social (Lochrin, Arciuli, & Sharma, 2015).

Stress, which is the focus of the present research, is one aspect of suprasegmental phonology or one of the main features of prosody as referred from the prior definitions. There are two distinct perspectives of stress: lexical stress and metrical stress. On one perspective, *lexical stress* refers to the relative prominence or the contrast between syllables within a word often involving variations in acoustic features such as intensity, pitch, and duration (Ko, 2002; Protopapas, Panagaki, Andrikopoulou, Gutiérrez Palma, & Arvaniti, 2016). In other words, a *stressed* syllable is often associated with greater intensity, higher frequency, and/or longer duration than their unstressed counterparts within words. The degree of relative prominence may not necessarily be binary, but syllables within a word are often classified into two groups: stressed vs. unstressed syllables (Protopapas, 2016). From the other perspective, *metrical stress* refers to the rhythmic sequence or pattern of strong and weak syllables across utterances even at above word-level (Gutiérrez-Palma, Defior, Jimenez-Fernández, Serrano, & González-Trujillo, 2016; Holliman, 2016).

CHAPTER II

THE RELATIONSHIP BETWEEN STRESS SENSITIVITY AND READING IN ENGLISH: A SYSTEMATIC REVIEW

Introduction

Over the past several decades, there has been a consistent consensus that phonological awareness is one of the strongest predictors of early reading development (e.g., Cain, 2010; Goswami & Bryant, 1990) and reading difficulties (e.g., Cain, 2010; Ramus et al., 2003). While beginning readers were found to outgrow the need for phonological awareness as they progress toward more advanced phases of reading development, morphological awareness has been spotlighted in the literature as another critical and widely acknowledged predictor of reading (Kuo & Anderson, 2006). More recently, in the last 10-15 years in particular, the literature has been growing rapidly on prosodic awareness and its relationship to reading development (e.g., Clin et al., 2009; Holliman et al., 2008; Mundy & Carroll, 2016; Whalley & Hansen, 2006; Wood et al., 2009). Among different aspects of prosody, stress sensitivity has been spotlighted with its contribution to reading (e.g., Jarmulowicz, 2016; Kim & Petscher, 2016; Mundy & Carroll, 2016), especially in the English language, given its importance in multisyllabic word reading (Holliman, Mundy, Wade-Woolley, Wood, & Bird, 2017). Despite the burgeoning literature, questions still linger concerning the relationship between stress sensitivity and reading development in English as well as the appropriateness of different measures being used in the literature. Therefore, it is timely and critical to systematically review the extant studies that examined the relationship between stress sensitivity and reading with regard to different measures used and mediating variables in the relationship.

Given the accumulating empirical evidence, several recent attempts have been made to model or disentangle the relationship between the prosodic sensitivity and reading development (Holliman, Critten, et al., 2014; Holliman, Gutiérrez Palma, et al., 2017; Kim & Petscher, 2016; Wood, Wade-Woolley, & Holliman, 2009). Wood et al. (2009) took their first step in modeling the contribution of speech rhythm sensitivity to reading and spelling via several pathways including phoneme awareness, rhyme awareness, and morphological awareness. Wood et al.'s (2009) final model was conceptualized by correlating vocabulary with rhyme and phoneme awareness, which further mediated the relationship between prosody and literacy (i.e., reading and spelling) in English, along with morphological awareness (see Figure 1). Later, using covariance structure modeling, Holliman, Critten, et al. (2014) made modifications to Wood et al.'s (2009) model by adding pathways among mediating variables. Two of the three modifications made by Holliman and his colleagues were the pathways from rhyme to morphology and phoneme to morphology, both of which belong to segmental aspects of phonology. The other modification was from rhyme to phoneme (cf. modifications are marked with blue dotted lines in Figure 2).

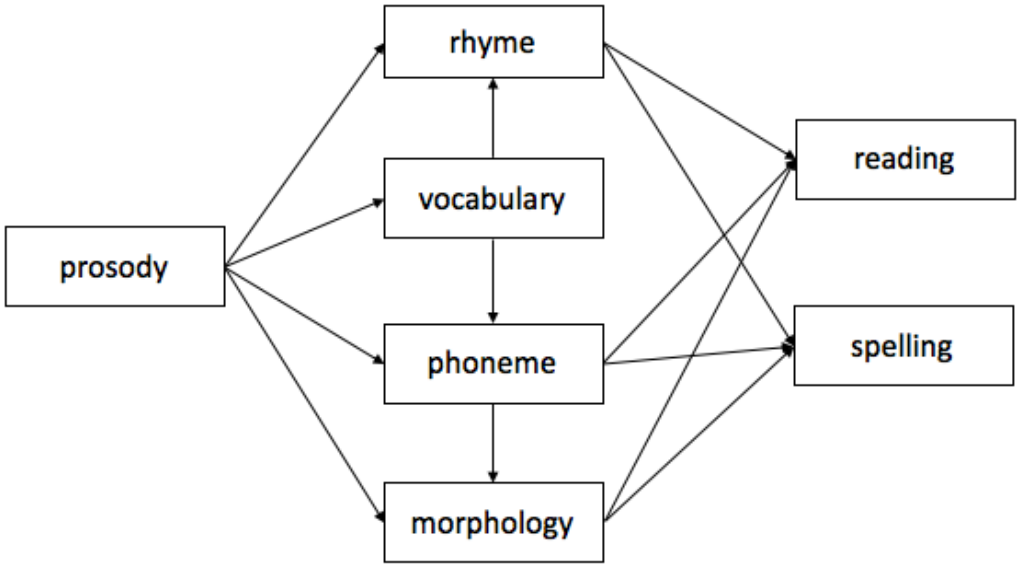

Figure 1. Conceptual path diagram of Wood et al.'s (2009) study.

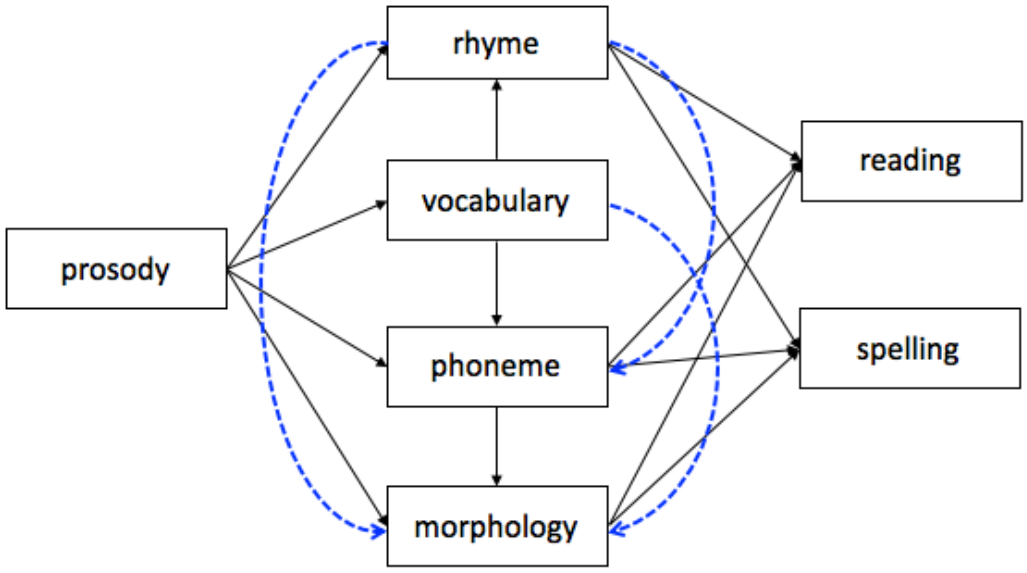

Figure 2. Holliman, Critten, et al.'s (2014) modification to Wood et al.'s (2009) prosody-literacy relationship model.

Using a latent variable approach, Kim and Petscher (2016) also examined the relationship between prosodic sensitivity and reading among English-speaking first-grade children (see Figure 3). Although vocabulary was not considered in the study, the authors reported two complete mediation models from prosodic sensitivity to word reading via phonological awareness and morphological awareness, and from prosody to reading comprehension via word reading and listening comprehension, without any direct pathway from prosodic sensitivity to reading. Most recently, however, Holliman, Gutiérrez Palma, et al. (2017) conducted a study with early readers of English who were 5 to 6 years old to find evidence of a unique contribution of prosodic sensitivity to word reading after controlling for phonological awareness, morphological awareness and vocabulary (see Figure 4). Moreover, Holliman and his colleagues also indicated stronger contributions of prosodic sensitivity and morphological awareness to multisyllabic word reading than the other two variables (i.e., phonological awareness and vocabulary).

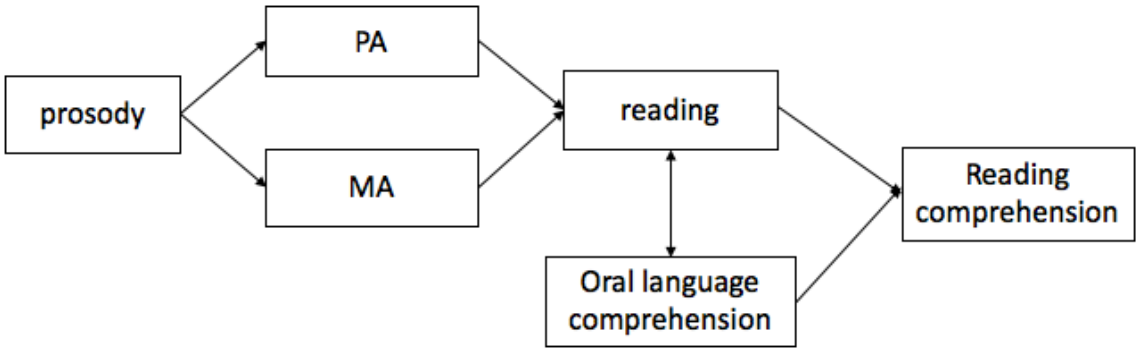

Figure 3. Conceptual path diagram of Kim & Petscher's (2016) model.

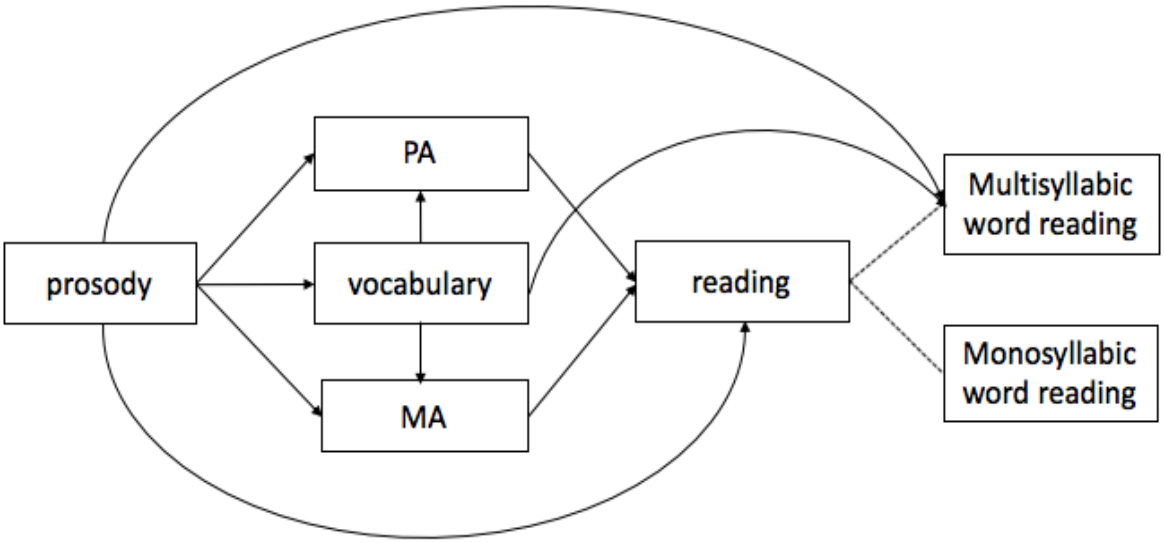

Figure 4. Conceptual path diagram of Holliman, Gutiérrez Palma, et al.'s (2017) model.

In addition to the fact that the models are still being developed and tested to disentangle the prosody-reading relationship, it should be noted that the literature suffers from mixed use of different terminologies to refer to varying aspects of prosody. Admittedly, researchers have been using some of the terms such as *prosody, stress,* or *speech rhythm* interchangeably in combination with *sensitivity, perception, processing,* or *awareness* depending on their measures or focus of the research (e.g., stress sensitivity, prosodic awareness, speech rhythm sensitivity, and stress perception etc.). Prosody can be defined as "the phonological subsystem that encompasses the tempo, rhythm and stress of language" (Whalley & Hansen, 2006, p. 288), "the stress and intonation patterns of a language" (Clin et al., 2009, p. 198), or "the rhythmic patterning of spoken language" (Holliman, Williams, et al., 2014, p. 256). Three major aspects of prosody include stress, timing, and intonation, which are manifested through variations in suprasegmental features such as loudness or intensity, length or duration, and pitch or fundamental frequency (Holliman, Williams, et al., 2014; Kim & Petscher, 2016; Whalley &

Hansen, 2006). As shown in the prior definitions, stress is one of the main features of prosody with two distinct perspectives: lexical stress and metrical stress. Researchers tend to distinguish these two terms so that *lexical stress* refers to the relative prominence or the contrast between syllables within a word, often involving variations in acoustic features such as intensity, pitch, and duration (Ko, 2002; Protopapas et al., 2016), while *metrical stress* refers to the rhythmic sequence or pattern of strong and weak syllables across utterances even at above word-level (Gutiérrez-Palma et al., 2016; Holliman, 2016). Although there are some overlapping areas between these two terms, and possibly due to such ambiguity, the present study attempts to review the extant literature that studied English lexical stress sensitivity or stress-related processing at the *word* level, not at the phrase or sentence level, by using the representative term, *stress sensitivity.*

Furthermore, for a better and more precise understanding of the relationship between stress sensitivity and reading, a careful investigation on a large variety of tasks that have been used to measure stress sensitivity at the word level. Researchers have been using and newly developing different tasks to assess stress sensitivity in English (see Wade-Woolley & Heggie, 2016 for a review). Different tasks may tap into distinctive aspects of stress sensitivity, which could also affect the relationship with reading ability. For example, the tasks that examine lexical stress at the word-level include the mispronunciations task (e.g., Holliman et al., 2008; Holliman, Critten, et al., 2014; Holliman, Williams, et al., 2014; Goodman et al., 2010), the aural stress assignment task (e.g., Wade-Woolley, 2016), and the derived word production task (e.g., Jarmulowicz, Taran, & Hay, 2007). On the other hand, some tasks such as compound noun tasks (e.g., Whalley & Hansen, 2006) or DEEdee tasks (e.g., Clin et al., 2009; Whalley & Hansen, 2006) are not restricted to word-level lexical stress (Arciuli, 2017). Task difficulty was another

important factor, especially in terms of different participant groups for experiments (Arciuli, 2017; Wade-Woolley, 2016). Considering the growing empirical evidence and importance of stress sensitivity to reading, there is an urgent need to review what kinds of measures have been used and whether there is any variation associated between the use of different measures and reading development.

The purpose of the present paper is to systematically review the empirical studies published in the last 20 years that examined the relationship between stress sensitivity at the word level and reading in English. This review specifically aims to answer the following questions: (a) what are the methodological characteristics of the literature? (b) what is the nature of relationship between stress sensitivity and reading in English? and (c) how was stress sensitivity measured, and are there any variations associated between the measures and the findings? Given the rapidly growing literature and importance of the topic, the present study is one of the first attempts to systematically review the existing literature to provide a better understanding and valuable insights for future researchers as well as practitioners.

Methods

Identification of Studies

The following three electronic databases were searched during February and March, 2018: ERIC, PsycINFO, and Academic Search Ultimate. To cast a wide net for finding studies on stress sensitivity at word level, the first search included the search terms as in S1: lexical stress OR prosod* OR stress sensitivity OR stress awareness OR prosodic sensitivity OR prosodic awareness. The second search was done with the search terms as in S2: reading OR word reading OR decoding OR word recognition OR reading comprehension to identify studies

on reading in general. Then, the first two searches were combined with AND (i.e., S1 AND S2) resulting in a total of 1749 studies identified.

Inclusion and Exclusion Criteria

For inclusion in the review, studies had to: (a) appear in a peer-reviewed, English language journal between January 1998 and February 2018; (b) empirically examine the relationship between stress sensitivity or processing and reading ability; (c) include any prosodic measure(s) for English stress at the word level; and (d) include at least one reading measure such as word reading or reading comprehension. Figure 5 presents the flowchart of literature search, screening, and selection process. Preliminary database search results were narrowed down using limiters of published date, scholarly (peer reviewed) journals, and language of English. After duplicates were eliminated, studies were screened in three-step procedures: title, abstract, and full-text screening. Studies were excluded if they did not have any kind of reading measures as well as stress-related measures at word level. The studies with the term metrical stress were kept separate for the full-text screening so that the ones with the stress measure at the word level could be included. Similarly, studies were excluded if their stress measure only focused on stress above word level. For example, Holliman, Mundy, et al.'s (2017) study was excluded because the DEEdee task measured stress at the phrasal level. As a result of the three-step screening procedures, finally 19 studies met these selection criteria. Manual searches and three-step screenings were done to all the references lists of the 19 selected studies, and one additional study was added to list, making a total of 20 studies comprising the final sample.

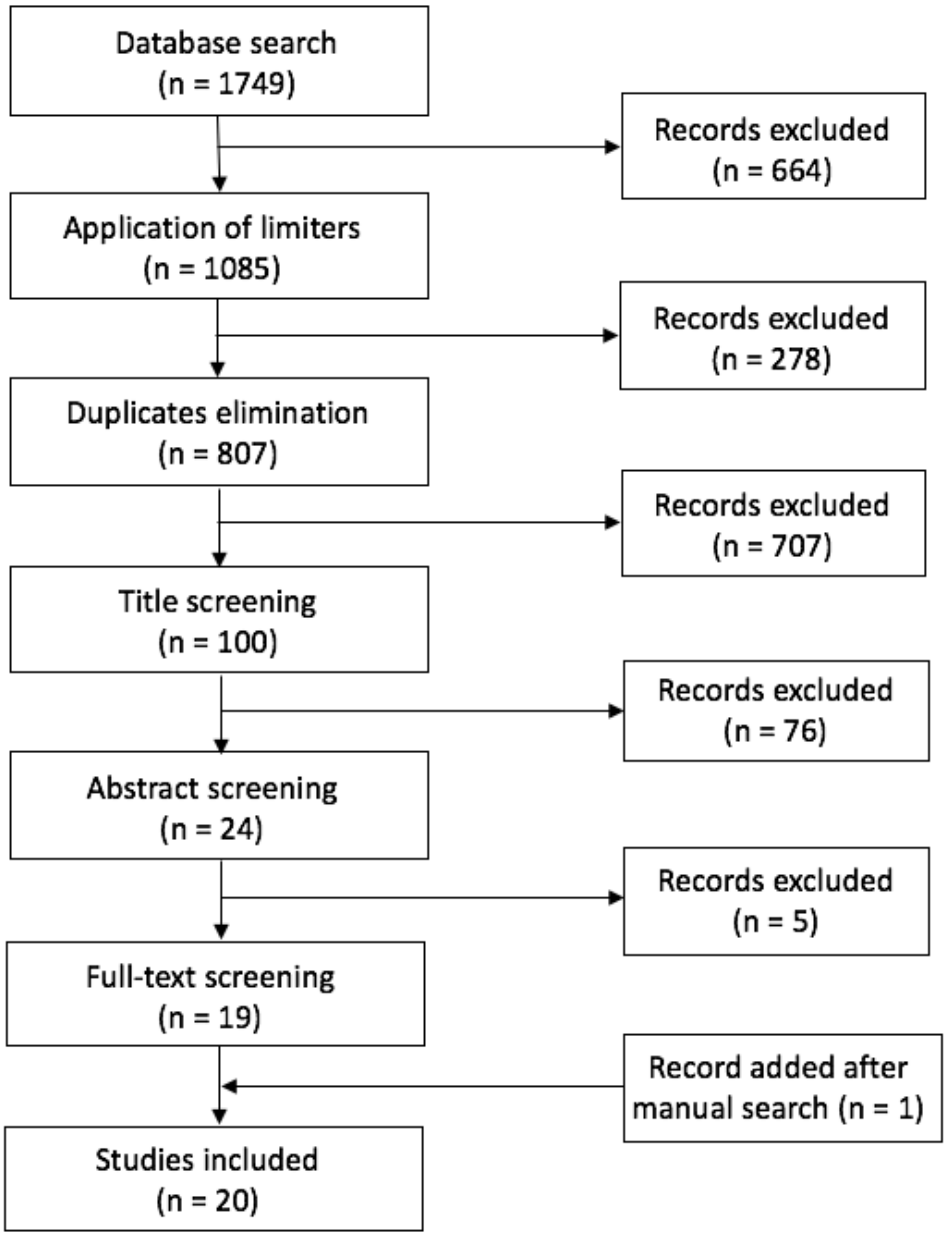

Figure 5. Flowchart of literature search, screening, and selection process.

Data Extraction and Coding

Each included study was independently reviewed and coded with a matrix system according to: (a) the nature of the relationship between lexical stress and reading ability; (b) moderating or mediating factors to the relationship if any; (c) participants' characteristics; (d) study designs; and (e) measures used for stress sensitivity, reading, and other linguistic measures (see Appendix A).

Results and Discussion

All 20 studies in the final sample were published between the years 2006 and 2017 although the search was done for the last 20 years (i.e., between January 1998 and February 2018). Of the 20 studies, more than half of the studies (n = 11) were published in the last four years (2014 - 2017). In terms of journals, more than half of the studies (n = 12) were published in reading-related journals, with *Journal of Research in Reading* being the journal with the most studies (n = 6). Five studies were identified in journals in the field of educational/cognitive/developmental psychology and three were found in language/linguistic journals. Regarding a variety of terminology used for "stress sensitivity" at the word level, the term *prosodic sensitivity* has been used the most (n = 6), followed by *stress sensitivity* (n = 5) including some variations such as *sensitivity to patterns of lexical stress* (Arciuli, 2017), *speech rhythm sensitivity* (n = 3), and *prosodic awareness* (n = 3). Some other studies used the terms such as *stress accuracy, stress production,* and *stress judgment.*

Studies' Methodological Characteristics

Considering that the present review identified empirical studies that examined the relationship between stress sensitivity and reading, it was anticipated that a majority of studies conducted correlational analyses. In terms of different study designs, almost all the studies were

cross-sectional studies except for one longitudinal study. The total number of participants varied from 29 to 370; the number of participants in each group including the studies with different groups ranged from 8 to 370. Except for two studies, all the rest of the 18 studies identified gender percentage of the participants. Of the 20 studies, only two studies focused on adult skilled readers of English, while a majority of studies (18) examined children's stress sensitivity, of which two studies also included adult participants—one as skilled readers, while the other for establishing ceiling levels on one of the tasks. The mean age of all the child participants in the 18 studies was 7.78 years (SD = 1.63), whereas that of all adult participants in three studies, excluding the adult group for the ceiling effect, was 23.37 years (SD = .49)

The majority of the studies had monolingual speakers of English (n = 18), although the other two studies were bilingual studies that examined English stress sensitivity among Mandarin (L1)-English (L2) bilingual speakers. Given the topic was stress sensitivity, monolingual English speakers in the 18 studies were classified into their residency: eight studies were conducted in the U.K. (British English), four studies in the U.S. (American English), three studies in Australia (Australian English), and three studies in Canada (Canadian English). Three studies out of the 18 studies mentioned that a small portion of their participants might have been exposed to different second languages at home. One study conducted in the U.S. examined the influence of social dialects on the relationship between stress accuracy and word reading by comparing non-mainstream American English speakers to mainstream American English speakers. In terms of participants with reading or developmental difficulties, only one study compared poor readers with age-matched and reading-matched control groups, and there was another study that included children with autism spectrum disorders (ASD). Lastly, only four out of 20 studies specified information on the participants' SES (socioeconomic status).

In terms of reading measures, all the studies assessed word reading (n = 20); about a half of the identified studies included nonword reading measures (n = 11); and only four studies had reading comprehension measures. Because the focus of the present review is on word-level stress sensitivity, it is not surprising to see the numbers of reading measures. The four studies with measures of reading comprehension included the one longitudinal study and the study with the biggest sample size, with a latent variable approach. More details on the use of different stress sensitivity measures and skills will be reported in the following section.

A review of methodological characteristics of the extant literature provides potential avenues for future empirical research. Considering the bilingual learners of English whose first language prosody differs from English prosody, more studies are needed to investigate how different bilinguals' stress sensitivity relates to their reading ability. Moreover, a research gap also exists regarding populations with reading difficulties, including both adults and children. Lastly, in terms of study designs, more longitudinal and interventional studies would contribute to the field with a better understanding and implications for theory and practice.

Nature of the Relationship Between Stress Sensitivity and Reading in English

As a general trend, a majority of the studies in the final sample were found to support a positive relationship between stress sensitivity and reading in English, although specific aspects of stress sensitivity or reading varied. No negative or inverse relationship was reported, but some studies reported mixed findings depending on different measures of stress sensitivity and reading. Almost all the studies reported correlation coefficients *r* along with the statistical significance (*p* value), while about half of the studies reported additional regression analyses to find out whether stress sensitivity was a unique predictor for reading in English. As Tables 1 and

2 show, the findings will be presented based on the relationship between stress sensitivity and three different reading measures: word reading, nonword reading, and reading comprehension.

Table 1
Percentage distribution of reviewed studies' findings—related to the association between stress sensitivity and word reading, nonword reading, and reading comprehension—based on correlation coefficient values

Finding: relationship between stress sensitivity and …	Statistically significant correlation n (%)	Mixed findings n (%)	Statistically non-significant correlation n (%)	Total n
Word reading	16 (84)	3 (16)	0 (0)	19
Nonword reading	7 (70)	3 (30)	0 (0)	10
Reading comprehension	3 (75)	0 (0)	1 (25)	4

Table 2
Percentage distribution of reviewed studies' findings—related to the unique contribution of stress sensitivity to word reading, nonword reading, and reading comprehension—based on regression analyses

Finding: stress sensitivity as a predictor of …	Unique contribution n (%)	Mixed findings n (%)	No unique contribution n (%)	Total n
Word reading	6 (50)	5 (42)	1 (8)	12
Nonword reading	2 (33)	1 (17)	3 (50)	6
Reading comprehension	0 (0)	0 (0)	2 (100)	2

First, regarding the relationship between stress sensitivity and word reading, statistically significant correlations were reported in most studies except for some mixed findings based on different stress sensitivity measures. Based on the correlation coefficient *r* values reported in a total of 19 studies, 16 studies found statistically significant correlation coefficients (*r* range = .208 - .755, M = .47, SD = .15). For the three studies that showed mixed findings, Chung and

Jarmulowicz (2017) found that Mandarin-speaking English adult learners' stress production in neutral derivation and stress judgment in nonneutral derivation was statistically significantly correlated with word reading (r = .479 and .523, respectively) while their stress judgment in neutral derivation and stress production in nonneutral derivation did not provide significant correlation with word reading. In another study, Wade-Woolley and Heggie (2015) showed that native English-speaking adults' performance in written suffix judgment tasks with both neutral and nonneutral derivation was significantly correlated with word identification, whereas that in aural suffix judgment with both types of derivation was not statistically significantly correlated with word reading. In addition, in a study that did not focus on different types of derivational suffixes and its relation to lexical stress, Mandarin-speaking children's stress production was correlated with word reading (r = .332) whereas their stress perception was not (Chung, Jarmulowicz & Bidelman, 2017).

In terms of the regression analyses, six studies indicated stress sensitivity as a unique predictor for word reading, five studies showed mixed findings, and one study did not find any unique contribution of stress sensitivity to word reading. For the six studies, stress sensitivity explained additional unique variance in word reading after controlling for different factors such as phonological awareness (n = 4), age (n = 3), vocabulary (n = 3), morphological awareness (n = 1), decoding skills (n = 1), and non-verbal IQ (n = 1). The studies with mixed findings include different conditions of stress sensitivity (e.g., dominant vs. non-dominant stress pattern, age of participants) that either did or did not predict unique variance in word reading. For example, children's performance on only non-dominant stress pattern, but not dominant stress, explained additional variance in word reading after controlling for age and phonological awareness (Arciuli, 2017). Similarly, only six-year-olds' stress sensitivity was a unique predictor for word

reading, but not among eight- and ten-year-old participants (Lin et al., 2018). Lastly, Kim and Petscher (2016) indicated that lexical stress sensitivity was completely mediated by phonological awareness and morphological awareness in its relationship to word reading.

Regarding the relationship between stress sensitivity and nonword reading, ten out of 11 studies reported correlations between stress sensitivity and nonword reading with values ranging from $.21 < r < .72$ (M = .47, SD = .17). Of these 10 studies, three studies reported mixed results based on different stress measures being used in their relation to nonword reading performance. An identical pattern to the word reading results was observed in two studies: Mandarin-speaking children's stress production performance was correlated with their nonword reading, whereas their stress perception was not (Chung et al., 2017); adult English speakers' performance in written suffix judgment, but not their aural suffix judgment, was correlated with nonword reading (Wade-Woolley & Heggie, 2015). Similarly but differently, adult Mandarin-speaking English learners' stress production in neutral derivation was correlated with nonword reading, but their performance in all other conditions (i.e., stress judgment in both neutral and nonneutral derivation and stress production in non-neutral derivation) did not show statistically significant correlation with nonword reading (Chung & Jarmulowicz, 2017).

Six additional regression analyses examined whether stress sensitivity plays a unique role in predicting nonword reading. Three studies did not find any additional contribution of stress sensitivity to nonword decoding, but two studies indicated stress sensitivity as a unique predictor of nonword reading even after controlling for age and non-verbal IQ (Chung et al., 2017) and phonological awareness and morphological awareness (Jarmulowicz et al., 2007). In one remaining study, stress sensitivity was found to account for independent variance in word reading only when age was not controlled (Wood, 2006).

Although limited in number, three out of four studies reported statistically significant correlations between stress sensitivity and reading comprehension (*r* range = .27 - .61, M = .39, SD = .19). Among the three studies that reported significant correlations, one study included stress sensitivity at the word level within the overall level of prosodic sensitivity; another study measured speech rhythm sensitivity with a longitudinal design; and the final study conducted confirmatory factor analysis with the general factor of prosodic sensitivity. The one study that did not find a significant correlation indicated that phrase-level prosodic sensitivity, but not word-level prosodic sensitivity, could account for additional variance in reading comprehension (Whalley & Hansen, 2006). Lastly, no study found stress sensitivity as a unique predictor of reading comprehension; however, Kim and Petscher (2016) reported significant indirect effects from stress sensitivity to reading comprehension via word reading and listening comprehension.

The present systematic review provides a theoretical contribution to the literature on the relationship between stress sensitivity and reading in English. The findings of this review confirmed that stress sensitivity is one of the significant predictors of reading in English. Among different models that attempt to disentangle the prosody-literacy relationship, the current review supports the recent model for the prosody-reading relationship suggested by Holliman and his colleagues (2017). As there have been some modifications to the initial model suggested by Wood et al. (2009), general findings of the review demonstrated the unique and independent contribution of stress sensitivity to reading. For word and nonword reading, 33 – 50% of unique contribution has been found, which could be higher if particular conditions were applied from the mixed findings. Moreover, in line with other models of prosody and reading, phonological awareness and morphological awareness have been found to be critical mediating factors in the

relationship between stress sensitivity and word reading (Holliman, Critten, et al., 2014; Holliman, Gutiérrez Palma, et al., 2017; Kim & Petscher, 2016).

Different Measures of Stress Sensitivity and Their Association with Reading

Listing all the names of stress sensitivity measures resulted in a total of 14 different tasks, which can be further classified into different groups based on the focus of stress sensitivity skills: stress manipulation, stress judgment, stress production, stress assignment, and stress matching skills. Table 3 presents different tasks used to measure various aspects of stress sensitivity with brief description, studies that used the task, and the stimuli used.

Table 3

Different measures of stress sensitivity

Skill	Task	Description	Study	Stimuli
Stress manipulation	The Mispronunciation Task	- The "metrical" stress of English disyllabic words with initial-stress were reversed to create mispronounced stimuli. - Child-friendly objects are presented in a drawing. - Pre-recorded stimuli - To answer: pointing to the objects in a drawing	Goodman, Libenson, & Wade-Woolley (2010)	19 disyllabic words with inverted syllabic stress (Vowel reduction not clearly mentioned)
			Holliman, Wood, & Sheehy (2008)	16 disyllabic words with inverted syllabic stress
			Holliman, Wood, & Sheehy (2010b)	16 disyllabic words with inverted syllabic stress
			Nash & Arciuli (2016)	16 disyllabic words with inverted syllabic stress (Vowel reduction not clearly mentioned)
			Wood (2006)	15 disyllabic words with inverted syllabic stress

Table 3 Continued

Skill	Task	Description	Study	Stimuli
	The Revised Mispronunciation Task	- Adapted from the mispronunciation task to overcome limitations - Simpler task with more distractors that match letter sounds and phonemes. - Pre-recorded stimuli - A forced choice task with four picture choices	Holliman, Wood, & Sheehy (2010a)	18 disyllabic words with inverted syllabic stress
			Holliman, Wood, & Sheehy (2010b)	18 disyllabic words with inverted syllabic stress
			Holliman, Wood, & Sheehy (2012)	18 disyllabic words with inverted syllabic stress
	Brenda' Animal Park Task – Stress	- Microsoft PowerPoint presentation with audio files - Only the stress at the word-level of the holistic measure was considered. - Decision making of whether a word was mispronounced or not - Adapted from Wood (2006), Holliman et al. (2008, 2010a, b, 2012)	Holliman et al. (2017)	NA
Stress judgment	Aural Suffix Judgment Task (ASJ)	- Sensitivity to stress patterns associated with knowledge of English derivational suffixes - Pre-recorded stimuli - A pseudoword stem was aurally presented first, then within a sentence. - A forced choice task of two alternative sentences - To answer: Circling 1 or 2 on a paper	Chung & Jarmulowicz (2017)	15 pseudowords with neutral suffixes 15 pseudowords with non-neutral suffixes
			Wade-Woolley & Heggie (2015)	15 pseudowords with neutral suffixes 15 pseudowords with non-neutral suffixes

Table 3 Continued

Skill	Task	Description	Study	Stimuli
	Lexical Decision Task (LDT)	- Stress-changed nonwords: change in the stress location of the real words (only initial, medial, but not final) - Phoneme-changed nonwords: change of one phoneme in the disyllabic words and two phones in the trisyllabic words - Decision making of whether a word was real or "silly" nonword - To answer: Pressing V or X	Lin, Wang, Newman, & Li (2018)	40 disyllabic words (20 initial-stressed, 20 final-stressed) 44 trisyllabic words (22 initial-stressed, 22 medial-stressed)
	Compound Noun Task	- Participants heard either noun phrases or compound nouns, differing only by prosodic features, and were asked to choose the best graphic that depicted the stimuli. - Prerecorded stimuli	Holliman et al. (2012)	20 test items A noun phrase only (e.g., *bow, tie, and shoe*) or a noun-phrase and a compound noun (e.g., *bow-tie and shoe*)
			Whalley & Hansen (2006)	Subtest 1: 20 test items that represent either two or three objects (e.g., *chocolate-cake and honey* vs. *chocolate, cake and honey*) Subtest 2: 12 test items (e.g., *highchair* vs. *high chair*)
Stress production	Derived Word Production Task (DWPT)	- First listen to the suffix and then the stem word, then combine the parts to form a derived word, and then produce it - Children's productions were digitally recorded for later transcription	Chung & Jarmulowicz (2017)	44 test items 20 neutral suffixes *(-ize, -ness, -ment*) 24 non-neutral suffixes (*-ity, -ic, -tion*)

Table 3 Continued

Skill	Task	Description	Study	Stimuli
			Jarmulowicz, Taran, & Hay (2007)	48 derived words (24 test items, 24 fillers) 24 real words suffixed with three rhythmic suffixes (*-ity, -tion, -ic*) 24 stem words with neutral suffixes (*-ness, -ize, -ment*) included as fillers
			Jarmulowicz, Taran, & Seek (2012)	16 derived word production (8 *-ity*, 8 *-ic*)
	Written Suffix Judgment Task (WSJ)	- Written stimuli were presented for reading aloud. - Responses were recorded on digital media.	Wade-Woolley & Heggie (2015)	Set 1: 30 pseudowords from ASJ Set 2: 30 pseudowords with suffixes (15 neutral, 15 nonneutral)
	DEEdee Task	- Participants were presented with a word and asked to produce the stress pattern by replacing each syllable with 'dee' - Responses were recorded.	Chung, Jarmulowicz, & Bidelman (2017)	12 disyllabic words
Stress assignment	Aural Stress Assignment Task	- Pre-recorded stimuli were presented first. - Participants were asked to say the word aloud and then repeat it - To answer: clapping the "main beat" - The researcher noted the clapped syllable for scoring.	Wade-Woolley (2016)	30 words (2- to 5-syllable long)

Table 3 Continued

Skill	Task	Description	Study	Stimuli
	Stress Assignment Task	- Pre-recorded stimuli - Children heard a pre-recorded single word, then asked to repeat the word out loud - To answer: clapping on the part with the strongest beat	Holliman et al. (2012)	15 words
	Word Stress Task	- Adapted from Holliman et al. (2012) - Pre-recorded stimuli were presented. - Participants were ask to mark the stress - To answer: pointing to a box (e.g., Elkonin box)	Kim & Petscher (2016)	24 real words (12 two-syllable words, 12 three-syllable words)
Stress matching	Alien Talking Underwater Task	- Two-alternative forced choice (2AFC) - Correct vs. incorrect lexical stress - Computer screen with pictures - Verbal choice - Responses noted by the researcher	Arciuli (2017)	28 words (with different lexical stress)
	Dina the Diver Task – Stress	- Dina the Diver: a cartoon character who say words (e.g., character names from popular books or TV shows) either above or under the water - Low-pass filtering of pre-recorded stimuli - Participants were required to match the correctly spoken utterance with the low-pass filtered versions. - A forced-choice task with images and scenes	Holliman, Critten, et al. (2014) Holliman, Williams, et al. (2014)	5 test trials assessing stress at the word level 15 stress test items at the word, phrase, and sentence levels (low-pass filtering) 5 test trials assessing stress at the word level (low-pass filtering)

One of the most widely used measures, the mispronunciation task (n = 5) and its revised version called the revised mispronunciation task (n = 4), belongs to the category of stress manipulation. Using disyllabic words with primary stress on the first syllable, the stimuli of the mispronunciation tasks were created by reversing the primary stress to the first syllable, leaving the second syllable unstressed. As a measure of stress sensitivity, children were assessed on their sensitivity to the manipulated word stress as they had to match the reversed stress to the original stress in the lexicon. To overcome some of the weaknesses of the original mispronunciation task, Holliman, Wood, and Sheehy (2010a, b, 2012) adapted the task as the revised mispronunciation task with a simpler format and more carefully designed distractors. Most recently, Holliman and his colleagues (2017) adapted the mispronunciation task and its revised version to the Brenda's Animal Park task as one of the four subtasks that aimed to measure a range of prosodic features.

One thing to note is that three of the five studies that used the mispronunciation task used the term "metrical stress sensitivity," possibly because the vowel of the first syllable became reduced while that of the second syllable was fully articulated, which reflects the perspective of metrical stress (Holliman et al., 2008, 2010b; Wood, 2006). However, because the task focused on the lexical stress reversal of the disyllabic English words at the word level, the other two studies referred to it as a measure of lexical stress or sensitivity (Goodman, Libenson, & Wade-Woolley, 2010; Nash & Arciuli, 2016). All the findings in both cases were included in the final analysis sample, given that the present review focused on English stress sensitivity at the word level regardless of the terminology being used.

In a broad sense, stress judgment was examined with three different tasks. The aural suffix judgment task was used to measure whether participants were able to accurately perceive English stress patterns along with their implicit knowledge of derivational suffixes that affect

stress assignment (Chung & Jarmulowicz, 2017; Wade-Woolley & Heggie, 2015). The lexical decision task (LDT) also required participants' judgment about whether they heard a real word or a funny pseudoword, with disyllabic and trisyllabic English words and stress-changed or phoneme-changed nonwords (Lin, Wang, Newman, & Li, 2018). As one of the popular prosodic measures, the compound noun task—to select one of the two drawings that best described stimuli (compound nouns vs. noun phrases)—was conducted in four different studies. Interestingly and similar to the point made in the discussion of the mispronunciation task, two studies (Goodman et al., 2010; Nash & Arciuli, 2016) referred the compound noun task as a prosodic measure of metrical stress while the other two studies (Holliman et al., 2012; Whalley & Hansen, 2006) regarded it as a prosodic measure at the word level: The former studies used the mispronunciation task as their sensitivity measure at the word level.

Skills on stress production was measured via three different tasks that involved recording of the participants' production. As the name suggests, the derived word production task (DWPT) was used in three of the studies (Chung & Jarmulowicz, 2017; Jarmulowicz et al., 2007; Jarmulowicz, Taran, & Seek, 2012). In this task, participants listened first to the derivational suffix and to the stem word. Then, they were asked to combine the suffix to the stem to produce a derived word in English. Chung and Jarmulowicz (2017) and Jarmulowicz et al. (2007) included both non-neutral and neutral suffixes while Jarmulowicz et al. (2012) only included two types of non-neutral suffixes. The names of the other two tasks do not seem to be closely related to stress production. The written suffix judgment task in Wade-Woolley and Heggie's (2015) study assessed whether skilled readers of English were able to use morphological information in reading pseudowords. Recordings were made of participants' production of a set of pseudowords and another set of pseudowords with two types of derivational suffixes. The last stress

production task was the expressive English DEEdee task (Chung et al., 2017), in which Mandarin-speaking children heard an English word and were instructed to produce the stress patterns using the syllable, *dee*. It is worth mentioning that the original DEEdee task is one of the commonly used tasks in prosodic sensitivity (Holliman et al., 2012; Whalley & Hansen, 2006), but the DEEdee task in these studies were excluded in the analysis because of the focus on prosodic sensitivity at the phrase level, not the word level.

Three different tasks were used for stress assignment. In both the aural stress assignment task (Wade-Woolley, 2016) and the stress assignment task (Holliman et al., 2012), participants first heard a pre-recorded English word and were asked to say it aloud and then to clap the part with the primary stress or the strongest beat. Similarly, Kim and Petscher (2016) adapted the task from Holliman et al. (2012) and required the participants to point to the box instead of clapping the main beat in their word stress task.

Finally, the last group of tasks were categorized as measures of stress matching skill. Arciuli (2017) recently created a new measure called the Alien Talking Underwater Task using low-pass filtered utterances with dominant and non-dominant lexical stress of English. Participants were asked to make a verbal choice between two pictures that they thought matched the stimuli. The Dina the Diver Task was also classified as a stress matching measure because the stress aspect of the holistic prosodic measure required participants to match a clear unfiltered utterance to a low-pass filtered utterance using a related picture (Holliman, Critten, et al., 2014; Holliman, Williams, et al., 2014).

The findings on different measures for stress sensitivity and their relationship to reading revealed that the field is still in need of reliable measures for future empirical studies with specific and general target populations. It is encouraging for researchers to develop new tasks for

measuring stress sensitivity at their desired level (e.g., word level or above word level). At the same time, more studies should attempt to replicate others' findings by adopting existing measures for stress sensitivity.

Conclusion

The purpose of the present study was to systematically review the empirical studies on the relationship between stress sensitivity at the word level and reading ability in English. Of the 20 studies in the final sample, a majority of the studies were correlational studies among monolingual English-speaking children. A variety of prosodic measures were used attempting to disentangle the associations between stress sensitivity and reading. Overall, the results of the review indicated that lexical stress sensitivity is significantly associated with word reading in English. Although more evidence is needed in concluding the exact pathways between prosody and reading, three variables—phonological awareness, morphological awareness, and vocabulary—were confirmed to play some mediating roles in the relationship.

This review contributes to the literature in the field of prosodic sensitivity or suprasegmental processing in its relationship to reading in two ways. First, despite the burgeoning empirical literature, especially in the last 5 to 10 years, little to none have focused on the relationship between stress sensitivity and reading development in English nor reviewed this body of literature systematically. This review will be one of the first attempts to fill that research gap demonstrating the importance of stress sensitivity as one of the major factors of reading in English. In addition, the present paper critically examines different measures of stress sensitivity in the extant literature where there are some discrepancies or ambiguities in using different measures as well as terminologies. This approach allows a more valid analysis of study designs for future research and a constructive discussion for pedagogical implications.

Nonetheless, the present review suffers from several limitations. The search was limited to the language of English for publication, but there could have been studies on English stress sensitivity and its contribution to reading published in non-English languages. In speaking of language, this study attempted to provide a focused review on only English lexical stress and reading, but it would be worthwhile to include monolingual and/or bilingual speakers of different languages to further illuminate the relationship between stress sensitivity and reading. Furthermore, given that some of the prosodic measures and terminologies on lexical and metrical stress have been used interchangeably, it would have been a more comprehensive review if the search extended to include stress sensitivity above the word level (i.e., to phrase and sentence levels). Last, a meta-analysis was not conducted due to vast variations among studies in terms of participants and measures.

Despite the limitations, however, the positive link between stress sensitivity and word reading in English supports recent and increased interest in the importance of prosodic sensitivity in reading development as well as the development of reading difficulties. The strength of this systematic review also include the possibility of including suprasegmental aspect of phonology in reading models as one of the independent and significant factors. This inclusion is especially critical when it comes to multisyllabic word reading in English (Wood et al., 2009).

There is still much room for improvement and for further investigation. Clearly, there is an urgent need for well-designed empirical studies with careful use of measures, terminologies, and study designs including longitudinal studies in order to better understand and disentangle the pathways from stress sensitivity to reading. More diverse characteristics of participants could expand our understanding by including bilingual speakers, and children with reading difficulties or autism spectrum disorders. Moreover, in terms of reviewing the growing literature, future

researchers can benefit from meta-analytic studies in the field of prosodic sensitivity and reading development. Last but not least, this systematic review provides important pedagogical and clinical implications. Considering the positive relationships between stress sensitivity and word reading, educators or clinicians can use stress sensitivity for diagnostic, supportive, or interventional purposes among children at different ages and stages of reading development.

CHAPTER III

SENSITIVITY TO DIFFERENT CUES TO ENGLISH LEXICAL STRESS AND WORD READING IN KOREAN-ENGLISH BILINGUAL ADULTS

Introduction

A majority of words in English are multisyllabic, and accurate assignment of lexical stress is essential but not always straightforward in reading multisyllabic words (Heggie, 2017; Holliman, Mundy, et al., 2017; Kearns, 2015; Sparks, 2018). As a stress-timed language, English carries primary lexical stresses at almost equal intervals in natural speech, usually having the alternating pattern of stressed and unstressed syllables (Ballard, Djaja, Arciuli, James, & Van Doorn, 2012; Calet, Gutiérrez-Palma, Simpson, González-Trujillo, & Defior, 2015; Wood, et al., 2009). Nonetheless, the patterns of lexical stress are not always predictable in English (Arciuli & Paul, 2012): Stress can be placed in any syllable position within a word in English without any diacritic to mark stress information in writing (Protopapas, 2016). Although English lexical stress is neither fixed nor marked in writing, there are two important cues to stress assignment in English—orthographic cues and morphological cues—which are the focus of the present study.

Orthographic Cues to Lexical Stress

The *orthographic cues* refer to the statistical or probabilistic information of particular letter sequences in English that is associated with lexical stress patterns (Arciuli & Paul, 2012; Monaghan, Arciuli, & Seva, 2016). Corpus analyses of English disyllabic words have shown that stress patterns—either trochaic or iambic—are associated with particular word endings (Arciuli & Cupples, 2006; Arciuli, Monaghan, & Seva, 2010) or word beginnings (Arciuli & Cupples, 2007; Kelly, 2004). For example, the word ending of *–um* tend to have stress on the first syllable

stress (e.g., *DICtum*) while the word ending of *–umb* is often associated with the second syllable stress (e.g., *sucCUMB*). Although languages vary in their association of stress patterns with either word beginnings or endings, English has shown some strong association between word endings and stress patterns (Arciuli & Cupples, 2006; Arciuli & Paul, 2012; Kelly et al., 1998; Monaghan et al., 2016).

Empirical and behavioral evidence has confirmed that native English speakers are sensitive to the orthographic cues to lexical stress. As one of the pioneering studies, Kelly and his colleagues (1998) demonstrated that certain orthographic cues with particular spelling patterns are associated with stress placement in English. Through naming and lexical decision tasks with visual stimuli, the authors found that native speakers of English processed words that were consistent in the spelling and stress patterns more accurately and promptly than those that were not. Along with the dictionary analysis that further developed prior findings on word endings-stress association, Arciuli and Cupples (2006) also demonstrated native English speakers' sensitivity to these orthographic cues to lexical stress when processing English nonwords. The authors reported that native English speakers made fewer errors with typically stressed words—trochaic nouns with stress on the first syllable and iambic verbs with the stress on the second—when compared to atypically stressed counterparts (i.e., nouns with second-syllable stress and verbs with first-syllable stress). Most recently, Sparks (2018) clarified the importance of written word endings as orthographic cues to lexical stress in English. Using various experiments, Sparks (2018) found that English-speaking adults rely on orthographic cues for stress assignment in disyllabic pseudowords confirming Arciuli and Cupples' (2006) study and for word recognition in isolation in line with Kelly et al.'s (1998) finding. The author further

emphasized the role of orthographic cues not only to reading words aloud but also to reading words without phonological output (Sparks, 2018).

Morphological Cues to Lexical Stress

As another type of cues to stress, derivational suffixes have been found to play a vital role in providing information for stress assignment in English (Chung & Jarmulowicz, 2017; Jarmulowicz et al., 2007; Wade-Woolley & Heggie, 2015). In English, one type of derivational suffixes—*neutral* suffixes—does not entail lexical stress shift when they are added to the stem (e.g., *-ment* in *MAnage – MAnage**ment***) while the other type—*nonneutral* suffixes—involves a shift in stress when added to the stem (e.g., *-ic* in *ARtist – arTIS**tic***; *-ity* in *CUrious – curiOs**ity***). Given that words in English tend to be more complex morphologically as they increase in length, these *morphological cues* have been found to be critical in multisyllabic word reading in English.

Empirical studies have supported the sensitivity to morphological cues and further contribution to reading abilities. Wade-Woolley and Heggie (2015) demonstrated that native speakers of English showed sensitivity to different types of derivational suffixes that condition stress assignment. The authors further reported correlation between the written suffix judgment task and general reading measures. Jarmulowicz et al. (2007) also indicated English-speaking third graders' accurate stress production in derived English words was a significant predictor of decoding ability. Adopting tasks from earlier studies, Chung and Jarmulowicz (2017) found that Mandarin-speaking adult English leaners' stress judgment in non-neutral derivation predicted word reading while their stress production in neutral derivation predicted both word and pseudoword reading, which are not in line with prior studies conducted among native English speakers. The authors attributed the discrepancies in the findings to the Mandarin-speaking adult English learners' lack of exposure or familiarity with English stress patterns associated with

derivational suffixes, especially non-neutral suffix cues. It seems worthwhile to investigate the relationship between derivational suffixes as cues to English lexical stress and word reading among other bilingual groups such as Korean-English bilingual speakers.

The Role of Stress Sensitivity in Reading

There has an emerging body of research that explores the role of lexical stress in literacy development (Holliman, Mundy, et al., 2017; Jarmulowicz, 2016; Kim & Petscher, 2016; Mundy & Carroll, 2016). Stress sensitivity has been found to contribute to reading development via several pathways and even uniquely. The first pathway is via phonological awareness. For instance, Goodman et al. (2010) revealed that lexical stress sensitivity was not a unique predictor for reading ability, although it explained some variance through its contribution to phonological awareness. Similarly, stress sensitivity has also been found to facilitate rime awareness (Holliman et al., 2008; Wood, 2006) and phoneme awareness (Clin et al., 2009; Holliman et al. 2008; Wood et al., 2009), which in turn facilitates word reading. Another potential pathway from stress sensitivity to word reading is through morphological awareness (Clin et al., 2009; Jarmulowicz et al., 2007; Wood et al., 2009). Clin et al. (2009) have reported moderate correlation between stress sensitivity and morphological awareness even after accounting for phonological awareness, age, and verbal/nonverbal abilities. This pathway through morphological awareness also concerns earlier discussion of morphological cues to lexical stress (Chung & Jarmulowicz, 2017; Jarmulowicz et al., 2007; Wade-Woolley & Heggie, 2015). Lastly, vocabulary may not be a direct mediator between prosody and word reading especially when phonological awareness and morphological awareness are taken into consideration (Wood et al., 2009). However, Holliman and his colleagues (2014a) found that children's vocabulary knowledge was a critical mediator in their path analysis: It completely mediated the relation of

prosody to awareness of both rhyme and morphology, and further to word reading and spelling, while it partially mediated the relation of prosody via phonological awareness. Despite these mediating factors, more and more researchers have reported empirical evidence of stress sensitivity being a unique, independent contributor to reading development (Arciuli, 2017; Holliman, Gutiérrez Palma, et al., 2017; Lin et al., 2016; Wade-Woolley, 2016). For example, Holliman and colleagues (2017) revealed that prosodic sensitivity, which includes the aspect of stress sensitivity, was a significant predictor of word reading even when individual differences in phonological awareness, morphological awareness, and vocabulary were taken into account. However, a review of literature on the relationship between stress sensitivity and reading revealed a major research gap: little has been studied with bilingual speakers of two languages with distinct prosodic systems. This study aims to address this gap by studying Korean-English bilingual whose two prosodic systems of first language (L1) and English, the second language (L2), vastly differ.

Korean Prosodic System

Given the potential importance of the L1 prosodic system in English stress assignment, the Korean prosodic system will be discussed in a brief manner. Korean word-level prosody has largely been a controversial topic and "a theoretical minefield" within the field of linguistics where different researchers have provided various analyses (Ko, 2013, p. 82). Although a few have argued for a fixed stress placement classifying Korean as a stress language (Lee, 1990), more scholars have agreed, based on their empirical studies, that Korean has neither fixed stress at a word level nor lexically contrastive stress, except for some cases of regional dialects (Guion, 2005; Lin, 2013; Jun, 1993, 2005). Unlike the stress accents of English at the word level, the tonal pattern applied at an accentual phrase level is the basic building block of prosody in Korean

(Altmann, 2006; Guion, 2005; Jun, 2005). In other words, the position of the prosodically strongest syllable of a word is variable within the accentual phrase in Korean whereas prosodic prominence is associated with a particular syllable within a word in English (Altmann, 2006). Also different from pitch-accent and tonal languages, Korean does not carry pitch or tonal contours at the word level (Altmann, 2006; Sohn, 1999). The prosodic system of Korean also differs from that of English in the underlying rhythmic unit along the continuum of stress-timed versus syllable-timed languages. In English as a stress-time language, stress occurs at certain intervals while Korean is classified as a syllable-timed language in which the main unit of rhythm that occurs at certain intervals is a syllable (Kim, Flynn, & Oh, 2007; Park, 2008).

Having no lexical stress in Korean, native Korean speakers were found to show difficulty in discriminating minimal pairs with only a stress difference (Lin, 2013). Evidently, Korean learners of English who have a different L1 prosodic system, may lack or further benefit from stress assignment information that includes statistical distribution of stress patterns in English (Guion, 2005). Considering differences in L1 and L2 prosodic systems, assigning stress to the right syllable of multisyllabic words can be particularly challenging for nonnative or bilingual readers, which has been one of the motivations of the present study.

The Present Study

The current study aims to fill the research gaps by conducting an empirical study that encompasses the crossover areas among the three research streams on English lexical stress. Three research questions will be addressed: (1) Do Korean-English bilingual adults exploit implicit knowledge of different cues to stress assignment signaled by orthographic cues (i.e., non-morphological letter strings of word endings) and morphological cues (i.e., English derivational suffixes that either entail stress shift or not); (2) How do different types of stress

cues influence stress assignment of English nonwords by Korean-English bilingual adults?; and (3) What is the relationship between stress sensitivity and reading ability, such as oral language and pseudoword reading?

Methods

Participants

Forty-one Korean-English bilingual adults in the U.S. participated in the present study (26 females and 15 males; M = 36.07 years, SD = 7.98 years). All the participants, whose native language is Korean, were born in Korea but have been residing in the U.S. more than 5 years (Mean length of stay in the U.S. = 11.59 years, SD = 4.54 years). Language Experience and Proficiency Questionnaire (LEAP-Q) were collected for additional language-related information (Marian, Blumenfeld, & Kaushanskaya, 2007).

Measures

Reading measures

To assess general reading ability of the participants, two standardized reading tasks were administered. The reading tasks included two subtests of the Woodcock Reading Mastery Test (WRMT-III; Woodcock, 2011): Word Identification and Word Attack. Similar to prior studies (e.g., Chung & Jarmulowicz, 2017; Wade-Woolley & Heggie, 2015; Whalley & Hanen, 2006), the Word Identification task and the Work Attack task were selected to measure real word reading ability in English and pseudoword decoding ability, respectively.

Orthographic cues to stress assignment task

Adapted from the tasks and stimuli used in the studies by Arciuli and her colleagues (Arciuli & Cupples, 2006; Arciuli & Paul, 2012), a list of 32 disyllabic nonwords including two practice items were used as probabilistic orthographic cues to English stress patterns (see

Appendix B). The stimuli were probabilistic orthographic cues with more than 50% chance to follow a particular stress pattern—either trochaic or iambic—depending on the word endings: Half of the nonword stimuli represent the trochaic stress pattern where the stress is placed on the first syllable of the disyllabic words (e.g., *-an, -age, -ern, -el, -ure, -on*) whereas the other half of the stimuli follow the iambic stress pattern with a stress on the second syllable (e.g., *-end, -ect, -ose, -uck, -oke*) (Arciuli & Cupples, 2006). For instance, the word ending of *–age* was found to be associated with trochaic stress pattern for 96.2% such as *COTtage* and *POStage* while the word ending of *–ect* showed a tendency to have a stress on the second syllable for 80% such as *proTECT* and *deTECT*.

The participants were asked to circle one of the segmented syllables that they would put an emphasis or stress on (see Appendix D). Based on the errors indicated in Wade-Woolley and Heggie's (2015) study, the participants' circling the stress syllable would be preferred to recording of production for two main reasons: (1) in order to avoid spondees—equal stress being placed to all syllables—and (2) to control the possible changes in the number of syllables and re-syllabification issues.

Morphological cues to stress assignment task

Motivated and influenced by Wade-Woolley and Heggie's (2015) study, a list of 32 stimuli has been created using the orthographic stimuli as stems for derivation (see Appendix C). Half of the stem stimuli had four types of neutral suffixes (i.e., *-ful, -ize, -ment, -er*) added while the other half had three types of nonneutral suffixes (i.e., *-ic, -ity, -tion*) affixed: The neutral suffixes refer to the suffixes that do not involve any change in stress as they are added to the stems, whereas the nonneutral suffixes refer to the suffixes that involve stress shift as they are added to the stems. For example, two types of derivational suffixes (e.g., *-ful* and *-tion*) have

been added to the pseudoword stimuli from the stress assignment tasks with probabilistic orthographic cues (e.g., *PLOsure* and *RANcel*). Participants scored 1 point if the stress has not been shifted with the neutral suffixes (e.g., *PLOsureful*) and if the stress has been shifted with the addition of the nonneutral suffixes (e.g., *rancelLAtion*). The participants' answers were compared to how they marked the stress of the bases in the Orthographic Cues to Stress Assignment Task, and 1 point was given based on the stress shift rules associated with suffix types.

Similar to the task on the orthographic cues to stress, the participants were asked to circle the syllable that they would put an emphasis or stress on (see Appendix E). Circling the stressed syllable has been chosen over recording of the production to control potential L1 influence on reading 3- and 4-syllable words (i.e., lack of lexical stress and monotonous characteristics in Korean prosody) as well as the possible changes in the number of syllables and re-syllabification issues. Although the word segmentation may differ slightly to the representation of the actual test, the focus of the present study will be on the assignment of stress in multisyllabic nonword reading depending on the suffix type.

Procedures

To control for effects of order or inattention, a counterbalanced design was applied with two sequences of task presentation. All participants were randomly assigned to two groups. One group was given the following task sequence: Word Identification, Stress Assignment Test of Morphological Cues, Word Attack, and Stress Assignment Test of Orthographic Cues. The reverse order of task sequence was applied to the other group.

Results

Table 4 presents descriptive statistics for all measures used in the present study. The first research question asked whether Korean-speaking bilingual speakers of English exploit implicit knowledge of different cues to stress assignment. Using one-sample t-test, the participants' performance was compared to the likelihood of correct stress by chance. The orthographic cues were disyllabic nonword stimuli with two syllables so the performance was compared at the change level of .50 (i.e., 50% chance of correct stress). The morphological cues consisted of 21 three-syllable nonwords (i.e., 33% chance of correct stress) and 9 four-syllable stimuli (i.e., 25% chance of correct stress). Thus, a weighted mean was calculated and the performance of morphological cues was compared at the chance level of .31. The performances for the neutral and nonneutral suffixes were also compared at the chance levels of .32 and .28, respectively.

The hypothesis that Korean-English bilingual adults would be sensitive to both orthographic and morphological cues to English lexical stress was confirmed. The one-sample t-test revealed that the participants outperformed chance in the orthographic cues ($t(40) = 11.34$, $p < .001$, 95% CI [18.47, 19.97]), and the morphological cues ($t(40) = 15.22$, $p < .001$, 95% CI [18.07, 20.76]). When it comes to specific subtypes of orthographic cues, the participants performed better than chance for both trochaic stress pattern ($t(40) = 9.51$, $p < .001$, 95% CI [10.03, 11.39]) and iambic stress pattern ($t(40) = 2.26$, $p = 0.0296$, 95% CI [7.60, 9.37]). Also for the two subtypes of morphological cues, the bilingual adults performed better than chance for both neutral ($t(40) = 17.44$, $p < .001$, 95% CI [9.10, 10.22]) and nonneutral suffix cues ($t(40) = 9.65$, $p < .001$, 95% CI [8.59, 10.92]).

Table 4

Descriptive Statistics for All Variables (N = 41)

	Max possible	M (% correct)	SD	Range
Orthographic Cues	30	19.22 (64.07)	2.38	15 - 24
Disyllabic pseudowords with trochaic stress	15	10.71 (71.38)	2.16	4 - 15
Disyllabic pseudowords with iambic stress	15	8.49 (56.59)	2.80	0 - 14
Morphological Cues	30	19.41 (64.72)	4.25	7 - 26
Derived pseudowords with neutral suffix	15	9.66 (64.39)	1.78	5 - 13
Derived pseudowords with nonneutral suffix	15	9.76 (65.04)	3.69	2 - 15
Word Identification	46	39.02 (84.84)	2.56	32 - 43
Word Attack	26	21.29 (81.89)	2.63	13 - 25

Note. The maximum number of items in each measure is shown in the Max possible column. The proportion of correct responses is shown in the parenthesis with the means.

The second research question asked whether different types of stress cues predicted the participants' performance on nonword stress assignment tasks. Using one-way repeated measures ANOVA tests, comparison was made between i) orthographic cues vs. morphological cues; ii) trochaic vs. iambic orthographic cues; and iii) neutral vs. nonneutral morphological cues. As a result of the first analysis, no statistically significant differences were found between orthographic cues and morphological cues ($F (1, 40) = .08$, $p = .78$), which confirmed the hypothesis. In the second analysis, one-way repeated measures ANOVA revealed statistically significant differences between the two subtypes of orthographic cues ($F (1, 40) = 10.53$, $p < .01$, $\eta^2 = .21$). The hypothesis that the bilingual adults would perform better with trochaic stress cues than iambic counterparts were confirmed ($p < .01$). Lastly, in comparing two subtypes of morphological cues, it was hypothesized that Korean-English bilingual adults would perform better with neutral derivational suffixes than nonneutral counterparts. In the contrary, one-way

repeated measures ANOVA revealed no significant differences were found between neutral and nonneutral suffix cues ($F (1, 40) = .03$, $p = .87$).

The third research question addressed how Korean-English bilingual adults' performance on stress assignment tasks was related to their word and pseudoword reading ability. Preliminary analyses revealed that the assumptions of normality and homoscedasticity was met. Table 5 shows Pearson's correlations for two major stress cue measures and reading measures and Table 6 presents Pearson's correlations for four subtypes of stress cue measures and reading measures. According to the first correlational analysis, the hypothesis was confirmed by showing statistically significant correlation between morphological cues and word reading ($r = .37$, $p < .05$) as well as between orthographic cues and pseudoword reading ($r = .32$, $p < .05$). More specifically, the second correlational analysis revealed that word reading was significantly correlated only with nonneutral suffix cues ($r = .38$, $p < .05$), whereas pseudoword reading showed a strong association only with the orthographic cues with trochaic stress ($r = .41$, $p < .01$).

Table 5

Correlations between the measures used in Study 2

	1	2	3	4
1. Orthographic Cues	-			
2. Morphological Cues	.20	-		
3. Word ID	.31	.37*	-	
4. Word Attack	.32*	.23	.64***	-

Note. *$p < .05$., **$p < .01$., ***$p < .001$

Table 6

Correlations between the measures including subtypes of orthographic and morphological cues used in the study

	1	2	3	4	5	6
1. OC_Trochaic	-					
2. OC_Iambic	-.55***	-				
3. MC_Neutral	-.10	.37*	-			
4. MC_Nonneutral	.31*	-.20	.10	-		
5. Word ID	.15	.14	.11	.38*	-	
6. Word Attack	.41**	-.03	.10	.22	.64***	-

Note. OC = Orthographic cues; MC = Morphological cues.

*$p < .05$., **$p < .01$., ***$p < .001$

Discussion

Accurate assignment of lexical stress is critical in English multisyllabic word reading (Holliman, Gutiérrez Palma et al., 2017; Holliman, Mundy, et al., 2017). In one stream of research, orthographic cues—spelling patterns that are associated with particular stress patterns—have been found to provide probabilistic information of stress assignment for English speakers (Arciuli & Cupples, 2006; Kelly et al., 1998). Another research stream demonstrated that morphological cues—English derivational suffixes that either involve shift in lexical stress—also play an important role in signaling stress assignment (Chung & Jarmulowicz, 2017; Jarmulowicz et al., 2007; Wade-Woolley & Heggie, 2015). Despite accumulating empirical evidence on different cues to English lexical stress, there remains a research gap in that few studies investigated how bilingual learners of English use or are sensitive to different cues to stress assignment. Therefore, the purpose of the present study was three-fold: (1) to examine

whether Korean-English bilingual adults are sensitive to orthographic and morphological cues to English lexical stress, (2) to compare potential differences among different types of stress cues on stress assignment performance, and (3) to investigate the relationship between sensitivity to stress cues and reading ability in English.

Sensitivity to Different Cues to Lexical Stress in English

The current study found that Korean-English bilingual adults showed sensitivity to both orthographic and morphological cues as they assign lexical stress to English pseudowords. For orthographic cues to stress assignment, the finding was in line with previous literature that supported native English speakers' sensitivity to orthographic cues as they place lexical stress to disyllabic word and or nonwords (Arciuli & Cupples, 2006; Kelly et al., 1998). English-speaking adults were found to reply on orthographic cues to lexical stress in naming and lexical decision tasks using both real words and nonwords in English (Kelly et al., 1998). In one of their experiments, Arciuli and Cupples (2006) also reported native English speakers' sensitivity to orthographic cues to stress assignment in disyllabic nonwords. The current finding makes contribution to the literature by providing evidence of bilingual speakers' sensitivity to orthographic cues as they assign stress to English nonwords. Despite differences in the two prosodic systems between English and Korean, the bilingual adults in the present study seemed to have enough exposure to different orthographic cues to stress assignment in English.

Regarding morphological cues to stress assignment, the finding of the current study confirmed the hypothesis that the Korean-English bilinguals would exhibit sensitivity to morphological cues as they assign lexical stress to English nonwords. This finding is consistent with prior studies that examined stress sensitivity to morphological cues among skilled readers of English (Wade-Woolley & Heggie, 2015) and Mandarin-speaking adults (Chung & Jarmulowicz,

2017). In Wade-Woolley and Heggie's (2015) study, English-speaking adults' sensitivity to morphological cues were measured with listening tasks in which the participants chose the sentence with derived nonword that sounded better as well as reading task in which reading aloud of derived nonwords were involved. In Chung and Jarmulowicz's (2017) study, Mandarin-speaking adults' morphological cue sensitivity was measured with stress judgment task adopted from Wade-Woolley and Heggie (2015) and stress production task adopted from Jarmulowicz' (2006) derived word production task (DWPT). The present study asked Korean-English bilingual adults to choose one of the pre-segmented syllables for stress assignment in order to minimize potential spondee issue, which is one of the common errors in stress production among Koreans by giving approximately equal weights to every syllable within a word (No, 1998; Park, 2008; Wade-Woolley & Heggie, 2015). Considering such differences in measures and participants in the literature, the present finding corroborates the importance of morphological cues to English lexical stress.

Comparison of Different Types of Stress Cues

In the first comparison, no statistically significant differences were found between orthographic cues and morphological cues in the bilinguals' performance on stress assignment. Confirming the hypothesis, this finding was consistent with recent study by Sparks (2018) who has made one of the first comparison between suffix and non-suffix word endings among native English speakers. Sparks (2018) concluded that both suffix and non-suffix word endings play equally important roles in stress assignment in English. Although Sparks (2018) used only disyllabic words as stimuli, the present bilingual study that included both orthographic cues with disyllabic nonwords and morphological cues with 3- to 4-syllable nonwords also provided empirical evidence that support the importance of both orthographic and morphological cues to

English lexical stress. Considering the mean length of stay among the participants (M = 11.59 years, SD 4.54 years), Korean-English bilingual adults in the present study can be assumed to have enough exposure to different cues to lexical stress similar to native speakers of English.

For comparison of two subtypes of orthographic cues, Korean-English bilingual adults in the present study exhibited better performance on the stimuli with the trochaic stress pattern than those with the iambic stress pattern. Given that trochaic stress pattern with the initial stress among disyllabic words is dominant in English, Korean-English bilingual adults may have placed the stress to the first syllable as a default strategy (Arciuli, 2017; Kelly et al., 1998). With enough exposure to English in the U.S., Korean-English bilingual adults in the current study also demonstrated trochaic bias prevalent among native speakers of English (Ballard et al., 2012).

Lastly, in comparing two subtypes of morphological cues, it was predicted that Korean-English bilingual adults would perform better with neutral suffix cues than nonneutral counterparts. Previously, Lee (2007) indicated that Korean-speaking adult English learners who are regarded as intermediate level in proficiency showed more difficulty with nonneutral suffixes than neutral suffixes. Better performance in stress production tasks with neutral suffix cues were also found among Mandarin-speaking adult English learners (Chung & Jarmulowicz, 2017) and English-speaking children who are 8- to 13-years-old (Clin et al., 2009). However, the current finding of no significant difference between neutral and nonneutral suffix cues was in line with Wade-Woolley and Heggie's (2015) study, in which English-speaking adults performed equally well with both neutral and nonneutral derivational suffixes. Considering the population—children or adult learners of English with different L1s—who had more difficulty with nonneutral suffix cues, it may require more time for mastery in stress assignment on nonneutral derivation than its neutral counterpart. If this is the case, the Korean-English bilingual adults in

the present study may be regarded as bilingual speakers with high proficiency in English or enough exposure to their L2, English in the U.S.

Relationship between Stress Cue Sensitivity and Reading in English

Given the potential importance of sensitivity to different stress cues in reading multisyllabic words in English, the third research question addressed how Korean-English bilingual adults' stress cue sensitivity was related to their English reading. The current findings confirmed that hypothesis that Korean-English bilingual adults' sensitivity to different stress cues were correlated to reading performances in English. To be specific, the present study found that the bilinguals' sensitivity to morphological cues with nonneutral suffixes was correlated with word reading while the participants' sensitivity to orthographic cues with trochaic stress pattern was correlated with pseudoword reading. Regarding the morphological cues, the current finding was in line with Chung and Jarmulowicz's (2017) study, in which Mandarin-speaking adults' stress judgment in nonneutral derivation was the only predictor of word reading. What was not consistent with Chung and Jarmulowicz's (2017) study was that Mandarin speakers' performance on stress production in neutral derivation was correlated with pseudoword decoding, whereas no such relationship was found in the present study.

Although little is known about the relationship between sensitivity to orthographic cues for stress assignment and word and/or pseudoword reading ability, it is not surprising to find the contribution of orthographic cues to pseudoword decoding, which relies more on the correspondence between graphemes and phonemes than prior stored knowledge in English words (Chung & Jarmulowicz, 2017). In other words, the current finding of significant correlation between orthographic cues and pseudoword reading could be attributed to Korean-English bilingual adults' experience with English. The more experience bilinguals have with their L2, the

more likely they are attuned to "probabilistic patterns" of stress assignments as well as better at pseudoword decoding (Park, 2008).

Limitations and Future Directions

The current study suffers from several limitations that warrant future research. First, the findings on the comparison between orthographic and morphological cues may need extra caution for interpretation. The caution is required due to the differences in the number of syllables: stimuli for orthographic cues were disyllabic nonwords while stimuli for morphological cues were three- or four-syllable nonwords. In a recent study, Sparks (2018) made a direct comparison between suffix cues and non-suffix cues by using disyllabic stimuli for both cues. However, differences in the number of syllables were inevitable if nonword stimuli for orthographic cues were to be used as bases for morphological derivation in two separate tasks. For future empirical studies, one possibility to control for this is to develop a single task that could tap into sensitivity to both orthographic and morphological cues.

Moreover, it should be noted that different formats of stress sensitivity tasks may entail differences in findings. In the present study, the forced choice task that requires circling one out of multiple pre-segmented syllables was chosen to minimize potential issues of spondee responses or syllabification. However, this task may not necessarily tap into production of stress because the participants are not required to verbally read out the stimuli. As noted in prior studies, different findings have been associated with different stress sensitivity tasks such as stress perception and stress production (Chung & Jarmulowicz, 2017; Wade-Woolley & Heggie, 2015). It will be important for future researchers to choose the most appropriate task for specific aspects of stress sensitivity.

Lastly, considering that the fundamental prosodic unit of Korean is accentual phrase, which is above lexical level, the present study can be extended to include stress and reading measures above the word level. For example, metrical stress measures such as DEEdee task (Holliman, Mundy, et al., 2017; Whalley & Hansen, 2006) can be included along with reading comprehension measures in connected text (Sparks, 2018). By doing this, future studies can benefit from a more comprehensive understanding of prosody-literacy relationship among the population of Korean-English bilingual speakers.

Despite the aforementioned limitations, the present study makes several major contributions to the literature. Considering the lack of studies that examined stress sensitivity among bilingual speakers, this study corroborates the importance of stress sensitivity as one of the aspects of suprasegmental processing, and to reading acquisition in English, among the bilinguals whose L1 (Korean) prosodic system differs widely from L2 (English). The findings further support the argument that lexical stress should not be disregarded in current reading models, especially with regard to multisyllabic word reading (Colombo & Zevin, 2009; Sulpizio, Burani, & Colombo, 2015). Furthermore, if replicated among different bilingual groups as well as English-speaking children, the findings have important educational and clinical implications. English learners may benefit from explicit training and instruction on the relationship between lexical stress and derivational suffixes (Lee, 2007) as well as particular spelling patterns (Arciuli & Cupples, 2006).

CHAPTER IV

KOREAN-ENGLISH BILINGUAL CHILDREN'S STRESS CUE SENSITIVITY AND ITS RELATIONSHIP WITH READING IN ENGLISH

Introduction

During the last decade or so, research has been rapidly growing on the role of prosodic skills to reading development. Lexical stress, as one of the major aspects of prosody, has been found to be a significant predictor for word reading in English (e.g., Goodman et al., 2010; Holliman et al., 2012, Nash & Arciuli, 2016). Some studies have found indirect contributions from stress sensitivity to word reading via several mediating factors such as phonological awareness (Clin et al., 2009; Kim & Petscher, 2016; Wood, 2006) and morphological awareness (Clin et al., 2009; Jarmulowicz et al., 2007; Kim & Petscher, 2016). More recently, empirical evidence is emerging for an additional, unique contribution of stress sensitivity to word reading independent of phonological awareness (Wade-Woolley & Heggie, 2016) as well as morphological awareness and vocabulary (Holliman, Gutiérrez Palma et al., 2017). The importance of stress sensitivity is particularly highlighted in multisyllabic word reading where accurate assignment of lexical stress is critical (Holliman, Gutiérrez Palma et al., 2017; Holliman, Mundy, et al., 2017). Despite the accumulating literature and the surge of interest in stress sensitivity, little has been known about the stress sensitivity of bilingual children who are exposed to two different prosodic systems from early ages.

It has been widely acknowledged that phonological awareness plays a critical role in early reading development in English (e.g., Cain, 2010; Goswami & Bryant, 1990) and even among bilingual children (e.g., Bialystok, 2002; Dixon, 2010). More recently, morphological

awareness has been spotlighted for its contribution to literacy development, especially among older children who are exposed to morphologically complex words (Nagy, Berninger, & Abbott, 2006), and from cross-linguistic perspectives (Kuo & Anderson, 2006). Stress sensitivity has been found to be another significant predictor of reading development along with, or even after controlling for, traditionally accepted variables such as phonological awareness and/or morphological awareness (Holliman et al., 2010b; Holliman, Gutiérrez Palma, et al., 2017; Whalley & Hansen, 2006).

Recently, researchers have begun to unravel the relationship between stress sensitivity and reading in English (Holliman, Critten, et al., 2014; Holliman, Gutiérrez Palma et al., 2017; Kim & Petscher, 2016; Wood et al., 2009). Wood et al. (2009) first proposed the model in which phoneme, rhyme, and morphological awareness were found to mediate the prosody-reading relationship, with vocabulary being correlated with phoneme and rhyme awareness. Later, Holliman, Critten, et al. (2014) modified Wood et al.'s (2009) model to include additional pathways from both rhyme and phoneme awareness to morphology, as well as the pathway from rhyme to phoneme. Although vocabulary was not included in the model, Kim and Petscher (2016) reported that prosodic sensitivity did not make a direct contribution to reading by proposing a complete mediation model via phonological awareness and morphological awareness. Most recently, however, a direct contribution of prosodic sensitivity to word reading, in particular multisyllabic word reading, has been found even after controlling for other variables such as phonological awareness, morphological awareness, and vocabulary (Holliman, Gutiérrez Palma, et al., 2017).

Different Cues to Lexical Stress in English

Accurate stress assignment in English, which is a stress-timed language that does not mark or restrict lexical stress in particular syllable position within a word, is particularly important in reading multisyllabic words (Cutler, 2015). Analogous to the studies that found the important contribution of morphological awareness to phonological awareness and reading development among children, morphology plays a significant role in stress awareness and further in reading development among children (Harrison & Wood, 2016). Specifically, derivational suffixes are shown to play a vital role in multisyllabic word reading in relation to the assignment of lexical stress in English (Chung & Jarmulowicz, 2017; Jarmulowicz et al., 2007; Wade-Woolley & Heggie, 2015). In English, the *neutral* derivational suffixes do not involve any change in lexical stress (e.g., the suffix of *-ness* as in *HAppy – HAppi**ness***) while the *nonneutral* suffixes tend to be involved in stress shift as being added to stem (e.g., the suffix of *-ity* as in *Equal – eQUAL**ity***) (Carlisle, 2000; Jarmulowicz et al., 2007; Wade-Woolley & Heggie, 2015). Regarding these derivational suffixes as cues to English lexical stress, positive relationships were found between word reading abilities and stress production among English-speaking children (Jarmulowicz et al., 2007), and stress judgment among English-speaking adults (Wade-Woolley & Heggie, 2015).

Most recently, Chung and Jarmulowicz (2017) combined both approaches to morphological cues among Mandarin-speaking adult English learners, and found that their stress judgment in non-neutral derivation predicted word reading while their stress production in neutral derivation predicted both word and pseudoword reading, which are not in line with prior studies conducted among native English speakers. The authors attributed the discrepancies in the findings to the Mandarin-speaking adult English learners' lack of exposure or familiarity with

English stress patterns associated with derivational suffixes, especially non-neutral suffix cues. It seems worthwhile to investigate the relationship between derivational suffixes as cues to English lexical stress and word reading among other bilingual groups such as Korean-English bilingual speakers.

In addition to the morphological cues, which concern stress shift based on specific types of derivational suffixes, there are non-morphological, *orthographic* cues that signal lexical stress in English. The orthographic cues are operationally defined as probabilistic information of non-morphemic letter strings that are associated with lexical stress patterns (Arciuli & Paul, 2012; Kelly, Morris, & Verrekia, 1998; Monaghan et al., 2016). Corpus analyses of English disyllabic words have shown that stress patterns are associated with particular word endings (Arciuli & Cupples, 2006; Arciuli et al., 2010) or word beginnings (Arciuli & Cupples, 2007; Kelly, 2004). For example, the word ending of *–um* tends to have stress on the first syllable, called *trochaic* stress (e.g., *DICt**um***), whereas the word ending of *–umb* is often associated with second-syllable stress, named *iambic* stress (e.g., *sucC**UMB***). Studies have found that native English speakers are sensitive to these orthographic cues to lexical stress. Kelly and his colleagues (1998) uncovered that native speakers of English had knowledge of orthographic correlates to stress in English disyllabic real words and nonword reading. Arciuli and Cupples (2006) further demonstrated native English speakers' sensitivity to these orthographic cues to lexical stress and grammatical categories when processing English nonwords. There exists a major research gap where there are very few studies that explored the orthographic cues to lexical stress and its contribution to reading among bilingual speakers of English. Prior studies that investigated the morphological cues to English lexical stress clearly stated the need to consider orthographic cues

that may play a critical role in word and/or nonword reading in English (Chung & Jarmulowicz, 2017; Wade-Woolley & Heggie, 2015).

Differences in Prosodic Systems: Korean vs. English

The prosodic system of Korean differs from that of English in a number of respects. First, unlike English having lexical stress, many researchers agreed that there is no lexical stress in Korean except for a few cases of regional dialects (Altmann, 2006; Guion, 2005; Lin, 2013; Jun, 1993, 2005). Prosodic prominence in Korean is associated at a higher than a word-level, which is called the accentual phrase (Altmann, 2006; Jun, 2005; Ko, 2013). The position of the prosodically strongest syllable of a word is subject to change within the accentual phrase in Korean while prosodic prominence is associated with a particular syllable within a word in English (Altmann, 2006). In other words, unlike the stress accents of English at the word level, the tonal pattern applied at an accentual phrase level is the basic building block of prosody in Korean (Altmann, 2006; Guion, 2005; Jun, 2005). Korean is also different from tonal languages, such as Mandarin, and pitch-accent languages, such as Japanese, in that tonal or pitch contours are not assigned at the word level in Korean (Altmann, 2006; Sohn, 1999). Moreover, in contrast to English being a stress-timed language, Korean is classified as a syllable-timed language along the continuum of stress-timed versus syllable-timed languages: The main unit of linguistic rhythm that occurs at certain intervals is a syllable in Korean, whereas stress occurs at certain intervals in English (Kim, Flynn, & Oh, 2007; Park, 2008).

Given the vast differences in prosodic systems between Korean and English, researchers have investigated how Korean learners of English process English stress at the word level. Some studies have indicated that Korean speakers demonstrate nonnative-like performance or encounter more difficulties in perception or production of lexical stress due to their L1

background (Guion, 2005; Park, 2008). For instance, when compared to native English speakers, Korean-English bilingual adults were found to have nonnative-like knowledge of English lexical stress, and the difference tended to be greater between the late bilinguals and native English speakers than between the early bilinguals and native English speakers (Guion, 2005). On the other hand, the possibility of enhanced sensitivity as well as facilitated acquisition based on dissimilarity between L1 and L2 has also been noted (Altmann, 2006). Altmann (2006) also mentioned that non-target-like performances among non-stress language speakers such as Koreans could be because the speakers do not have enough experiences with lexical stress, not because of L1 interference, which is not possible due to a negative parameter for stress in non-stress languages. Evidently, Korean learners of English who have a different L1 prosodic system, may lack or further benefit from stress assignment information that includes statistical distribution of stress patterns in English (Guion, 2005). Considering differences in L1 and L2 prosodic systems, assigning stress to the right syllable of multisyllabic words can be particularly challenging for nonnative or bilingual readers, which has been one of the motivations of the present study.

Computational Models of Reading

Most of the reading theories or computational models of reading have focused on monosyllabic words or nonwords despite multisyllabic nature of English language. In the last two decades, attempts have been made to expand the models to include disyllabic words and to deal with stress assignment (e.g., Coltheart, 2000; Perry et al., 2010; Ševa et al., 2009). For the purpose of the present study that includes disyllabic nonwords, a brief introduction of computational models of disyllabic word reading will be provided. However, it should be noted that the current study also includes nonword stimuli with more than three syllables.

One approach is rule-based, dual-route models of disyllabic reading, in which suffixes play a critical role as cues to English stress assignment. (Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001; Rastle & Coltheart, 2000). As an extension of the dual-route theory of reading, for example, the Dual-Route Cascaded (DRC) model of reading by Coltheart and his colleagues involves both the lexical routes for whole words or exception words and the nonlexical or sublexical routes for nonwords governed by a set of stress rules when assigning stress to disyllabic words (Coltheart, 2000; Coltheart et al., 2001). Empirical evidence has shown that the DRC model could predict stress assignment in disyllabic English nonwords at a level higher than chance (Rastle & Coltheart, 2000), but some issues were found for nonwords without prefixes and suffixes that were pre-determined in the procedure (Kelly, 2004; Ševa et al., 2009).

On the other hand, the connectionist models of word recognition emphasize the importance of non-suffix, orthographic regularities to stress assignment (Perry et al., 2010; Ševa et al., 2009). Without any predetermined linguistic rules of prefixes and suffixes, Ševa et al. (2009) suggested the connectionist framework that learns to map orthographic letter slot(s) to stress position for disyllabic words in English. Ševa et al.'s (2009) connectionist model performed slightly better than rule-based model on stress assignment to disyllabic words but not to nonwords. To complement shortcomings of the dual-route model and Ševa et al.'s (2009) connectionist model, Perry, Ziegler, and Zorzi (2010) developed a full processing model, the CDP++ (Connectionist Dual Process) model. The CDP++ model successfully predicts stress assignment among over 32,000 English disyllabic words by considering different factors such as stress typicality and syllable frequency (Perry et al., 2010).

The Present Study

To my knowledge, the current study is one of the first studies that attempts to consider both morphological and orthographic cues to lexical stress in a single study, and further to reading development in English. Despite the growing literature in the field, there is also an apparent lack of studies that examine the relationship between stress sensitivity and reading among bilingual child speakers of English, who are exposed to two different prosodic systems from early ages. Thus, it is worthwhile to investigate bilingual children's sensitivity to different cues to English lexical stress, as they place stress in English multisyllabic nonwords. Considering the aforementioned differences in prosodic systems between English and Korean, the under-researched group of Korean-English bilingual children can contribute to the literature on the prosody-literacy relationship among bilingual speakers.

The rationale for selecting the age groups of 8- to 10-years old bilinguals was two-fold. First, given that both of the stress assignment tasks involve multisyllabic nonwords with derivational suffixes, 8- to 10-year-old children (grades 3-5) were selected because they are expected to have mastered basic decoding skills and to have been exposed to different derivational suffixes. As children progress through the first few years of literacy education at school, most of them become comfortable with decoding words and nonwords. However, from around grade 2 when literacy instruction starts to emphasis multisyllabic word reading, children are exposed to a drastically growing number of multisyllabic words each year until around grade 5 (Schwanenflugel & Knapp, 2015; Kearns et al., 2016). Given the multisyllabic nature of English as a stress-timed language, processing of lexical stress has been found as another critical factor for English word reading, especially in reading multisyllabic words, even among older elementary students (Holliman, Mundy, et al., 2017). Recent studies have indicated that prosodic

or stress sensitivity is an independent predictor of reading (Wade-Woolley, 2016) that develops at a slower pace than phoneme sensitivity even with early literacy education (Holliman, Mundy, et al., 2017; Lin et al., 2016). Prior empirical studies have also indicated the importance of examining the developmental aspect of stress processing or sensitivity among similar age groups (Arciuli & Ballard, 2017; Clin et al., 2009; Holliman, Mundy, et al., 2017; Jarmulowicz, 2006; Jarmulowicz et al., 2007).

Taking all these considerations into account, the present study aims to investigate whether speakers of different prosodic systems are sensitive to different cues in assigning stress to English nonwords and how such stress sensitivity is related to reading ability by studying Korean-English bilingual children. The first research question addresses whether Korean-English bilingual children in grades 3 to 5 show sensitivity to different cues to stress assignment in English, either signaled by morphological suffix cues (i.e., English derivational suffixes) or non-morphological orthographic cues (i.e., non-morphemic word endings). The second research question asks whether different types of stress cues play a role in stress assignment in English nonwords. Lastly, the third research question seeks to examine the relationship between Korean-English bilingual children's sensitivity to different stress cues and their reading ability (i.e., oral language and pseudoword reading).

Methods

Participants

A total of 42 Korean-English bilingual children, who are in grades 3 to 5 in elementary schools, participated in the present study (27 girls, 15 boys; Mean age = 115 months, SD = 9.18 months). All the participants are simultaneous bilingual children who are from Korean-speaking homes (both parents are native speakers of Korean) and attend English-speaking schools in

California, U.S. Additional language and developmental background information was collected by a questionnaire completed by one of the parents (see Appendix F). All the participants are typically developing children without any vision or hearing impairment as well as mental or learning disabilities such as dyslexia or autism. However, three children were excluded from the analysis because one was found to be in trilingual environment at home and for the other two children, the bilingual parent questionnaire was not completed. As a result, 39 Korean-English bilingual children (24 girls, 15 boys; Mean age = 114.33 months, SD = 8.7 months) were included for analyses.

Measures

Reading measures

Two standardized reading tasks—Word Identification and Word Attack subtests of the Woodcock Reading Mastery Test (WRMT-III; Woodcock, 2011)—were used to assess bilingual children's general reading ability. Following prior studies (e.g., Chung & Jarmulowicz, 2017; Wade-Woolley & Heggie, 2015; Whalley & Hansen, 2006), the Word Identification subtest which asked children to read a list of real words in English was used to measure word recognition ability while the Word Attack subtest, which included a list of pseudowords, was administered to measure decoding ability of the participants. Following the test manual for both reading tasks, testing was stopped when the participants made four consecutive scores of 0. Mean grade-based reliability estimates were reported as .91 and .89, for the Word Identification subtest and the Word Attack subtest respectively.

Orthographic cues to stress assignment task

The "orthographic cues task" was adapted from earlier studies by Arciuli and her colleagues (Arciuli & Cupples, 2006; Arciuli & Paul, 2012). A list of 32 disyllabic nonwords,

including two practice items, were included to measures Korean-English bilingual children's sensitivity to probabilistic orthographic cues as they assign English lexical stress (see Appendix B). All the orthographic cues of particular word endings showed more than 50% chance of following a particular stress pattern in English. In other words, half of the stimuli (e.g., *-an, -age, -ern, -el, -ure, -on*) were associated with the first-syllable, *trochaic* stress pattern while the other half (e.g., *-end, -ect, -ose, -uck, -oke*) with the second-syllable, *iambic* stress pattern in English. For example, the word ending of *-an* was found to carry the trochaic stress for 90.73% of chance as in nonword stimuli such as *CURban, REgan* whereas the word ending of *-uct* was found to be associated with the iambic stress for 85.71% as in *troDUCT* and *fe*DUCT (Arciuli & Cupples, 2006). Although Arciuli and Cupples (2006) also discussed grammatical information associated with the word endings, the present study did not consider the probabilistic information from grammatical categories to focus on the association between word endings and stress patterns.

To examine the bilingual children's sensitivity to the orthographic cues to stress assignment, the participants were asked to circle one of the two syllables of disyllabic nonwords that they would put an emphasis or stress on (see Appendix D). The circling of the syllable method was chosen over actual production of the stimuli to minimize potential issues indicated in prior studies. The forced choice task was used to avoid spondee response in which participants place equal stress to all syllables (Wade-Woolley & Heggie, 2015) and to control for potential memory load and re-syllabification issues (Chung & Jarmulowicz, 2017). For scoring, 1 point was given if the stress was placed on the first syllable for the half of the stimuli aiming for trochaic stress as well as if the stress was assigned to the second syllable for the other half of stimuli designed for iambic stress pattern. Maximum score total was 30.

Morphological cues to stress assignment task

The development of the "morphological cues task" was motivated by Wade-Woolley and Heggie's (2015) study. Using the list of 32 disyllabic nonwords used in the orthographic cues tasks as stems, another list of 32 multisyllabic nonwords were created by adding different derivational suffixes in English (see Appendix C). Following Wade-Woolley and Heggie's study, half of the stimuli for the morphological cues task included four types of neutral suffixes that do not involve any change in lexical stress as being added to the stem (i.e., *-ful, -ize, -ment, -er*) whereas the other half were three types of nonneutral suffixes that involved stress shift as they are affixed (i.e., *-ic, -ity, -tion*). For instance, two stimuli of *HISpelment* and *hatCHElic* were created by adding two types of derivational suffixes (e.g., *-ment* and *-ic*) to the nonword stimuli from the orthographic cues task (e.g., *HISpel* and *HATchel*). For scoring, 1 point was given if the stress was not shifted among neutral suffix cues (e.g., *HISpel* → *HISpelment*) and if the stress was shifted among nonneutral suffix cues (e.g., *HATchel* → *hatCHElic*). The responses from the orthographic cues tasks were used to check whether there is a stress shift as derivational suffixes are added to the nonword stems depending on two different types of suffixes. Maximum score total was 30.

The test format was the same with the orthographic cues task where the participants were asked to circle one of the segmented syllables that they would put the strongest emphasis or stress on (see Appendix E). The difference is that the disyllabic stimuli in the orthographic cues task had only two choices but the stimuli in the morphological cues task were longer nonwords with three or four syllables. Although the word segmentation may differ slightly to the representation of stimuli, the method of circling the stress syllable was chosen over actual

production of the stimuli considering that the participants in grades 3 to 5 could focus on stress assignment only without potential issues on re-syllabification of multisyllabic words.

English receptive vocabulary

Following Lin et al. (2016)'s study, a standardized test of Peabody Picture Vocabulary Test-IV (PPVT-IV; Dunn & Dunn, 2007) was administered to measure the Korean-English bilingual children's English receptive vocabulary. The test followed standardized testing and score procedures.

Korean receptive vocabulary

Given that proficiency levels in Korean may vary vastly among Korean-English bilingual children, the Receptive and Expressive Vocabulary Test (REVT; Kim, Hong, Kim, Chang, & Lee, 2009) was administered to assess their Korean receptive vocabulary. The test followed standardized testing and score procedures.

Procedures

A counterbalanced design was applied to control for effects of order or inattention. The participants were randomly assigned to one of the two groups. Participants who belonged to the first group were given the tasks in the order of English receptive vocabulary, Stress Assignment Test of Orthographic Cues, Word Attack, Word Identification, Stress Assignment Test of Morphological cues, Korean receptive vocabulary. The second group followed the reverse order of task sequences. The tests were given individually in a quiet room in one session, which took about 30 minutes per session on average. Strictly following all protocol suggested by IRB, the participants were told that they could stop the tests at any time of the procedure if needed.

Results

Descriptive statistics for all measures are presented in Table 7. The first research question asked whether Korean-English bilingual children showed sensitivity to different cues to stress assignment in English. The hypothesis was that Korean-English bilingual children would demonstrate their sensitivity to both morphological and orthographic cues to lexical stress in English nonword reading. To test this, a one-sample t-test was used to compare their performance to the likelihood of correct stress by chance. The stimuli for the orthographic cues being two-syllable nonwords, the performance was compared at the chance level of .50 (i.e., 50% chance of correct stress). For the stimuli for the morphological cues, there were 21 three-syllable nonwords with the chance level of .33 (i.e., 33% chance of correct stress) and 9 four-syllable nonwords with the chance level of .25 (i.e., 25% chance of correct stress). Using a weighted mean, the performance on morphological cues was compared at the chance level of .31. With the same approach for the two types of derivational suffixes, the chance levels of correct stress were calculated as .32 for the neutral suffixes and .28 for the nonneutral suffixes, respectively.

As a result of one-sample t-tests, the hypothesis that Korean-English bilingual children are sensitive to the morphological and orthographic cues was confirmed. Korean-English bilingual children were found to perform better than chance in the morphological cues ($t(38) = 6.65$, $p < .001$, 95% [12.61, 15.50]), and the orthographic cues ($t(38) = 5.57$, $p < .001$, 95% CI [16.79, 18.85]). More specifically, for the orthographic cues, participants performed better than chance at assigning correct stress to the stimuli with both trochaic ($t(38) = 2.44$, $p = .019$, 95% CI [7.64, 9.02]) and iambic stress patterns ($t(38) = 4.71$, $p < .001$, 95% CI [8.63, 10.34]). Also for the morphological cues, bilingual children showed performances significantly better than

chance in both neutral (t(38) = 6.03, p < .001, 95% [6.41, 8.05]) and nonneutral suffix cues (t(38) = 5.87, p < .001, 95% [5.93, 7.76]).

Table 7

Descriptive Statistics for All Variables (N = 39)

	Max possible	M (% correct)	SD	Range
Morphological Cues	30	14.05 (46.84)	4.46	7 - 25
Derived pseudowords with neutral suffix	15	7.23 (48.21)	2.52	3 - 14
Derived pseudowords with nonneutral suffix	15	6.85 (45.47)	2.81	3 - 13
Orthographic Cues	30	17.82 (59.40)	3.16	9 - 23
Disyllabic pseudowords with trochaic stress	15	8.33 (55.56)	2.13	4 - 13
Disyllabic pseudowords with iambic stress	15	9.49 (63.25)	2.63	5 - 14
English Vocabulary	228	149.26 (65.46)	16.30	109 - 185
Korean Vocabulary	185	65.23 (35.26)	23.87	27 - 146
Word Identification	46	33.97 (73.86)	5.65	21 - 46
Word Attack	26	20.15 (77.51)	2.76	14 - 24

Note. The Max possible column refers to the maximum number of items in each measure. The proportion of correct responses is shown in parentheses with the means.

The second research question aimed to examine whether there are differences between various types of stress cues and the Korean-English bilingual children's performance on nonword stress assignment tasks. To address this research question, three separate one-way repeated measures ANOVA tests were performed for the following comparison: i) morphological cues vs. orthographic cues; ii) two subtypes of morphological cues with neutral vs. nonneutral derivational suffixes; and iii) two subtypes of orthographic cues with trochaic vs. iambic stress patterns. In the first analysis, statistically significant differences were found among two major types of cues—morphological cues vs. orthographic cues—to lexical stress, F (1, 38)

= 32.35, $p < .001$, $\eta^2 = .45$. The finding confirmed the hypothesis that the participants would perform better in the stress assignment of the orthographic cues than that of morphological cues ($p < .001$). Contrary to the second hypothesis that the bilinguals would perform better on morphological cues with neutral suffixes, the result of one-way repeated measures ANOVA revealed no statistical significance between two subtypes—neutral and nonneutral—of morphological cues ($F (1, 38) = .73$, $p = .398$). Regarding the comparison of orthographic cues with trochaic and iambic stress patterns, the result of the one-way repeated measures ANOVA was approaching significance ($F (1, 38) = 4.00$, $p = .053$), which does not confirm the hypothesis of better performance with trochaic stress patterns.

The third research question addressed the relationship between Korean-English bilingual children's performance on stress assignment tasks and their word and pseudoword reading. Preliminary analyses revealed that the assumptions of normality and homoscedasticity were met. Table 8 presents Pearson's correlations for all measures. Correlational analysis did not reveal any statistically significance correlation among stress assignment tasks and word and pseudoword reading. Even when the two types of cues to lexical stress were further analyzed into their subtypes, no statistical significance was found in the relationship between stress sensitivity and word and pseudoword reading performance. Therefore, the hypothesis that the bilingual children's stress assignment performance was correlated with reading ability was not confirmed in the current study.

Table 8

Correlations between the measures used in Study 3

	1	2	3	4	5	6
1. English Vocabulary	-					
2. Korean Vocabulary	-.18	-				
3. Orthographic Cues	-.24	.22	-			
4. Morphological Cues	-.05	.26	.45**	-		
5. Word ID	.48**	-.30	-.16	-.05	-	
6. Word Attack	.15	-.02	-.14	-.08	.55***	-

Note. $*p < .05.$, $**p < .01.$, $***p < .001$

Discussion

In multisyllabic word reading in English, accurate assignment of lexical stress is essential (Holliman, Gutiérrez Palma et al., 2017; Holliman, Mundy, et al., 2017). A growing number of studies reported that both native speakers of English and English language learners are sensitive to morphological cues, referring specifically to English derivational suffixes with or without stress shift (Chung & Jarmulowicz, 2017; Jarmulowicz et al., 2007; Wade-Woolley & Heggie, 2015). On the other hand, native speakers of English have been found to be sensitive to orthographic cues, which refer to certain spelling patterns or letter strings that provide probabilistic cues to stress assignment (Arciuli & Cupples, 2006; Kelly et al., 1998). Despite the surge of interest, few attempts have been made to investigate both the orthographic and morphological cues to English lexical stress, especially among bilingual speakers with two different prosodic systems. Furthermore, considering the recent increase in interest in trying to unravel the prosody-literacy relationship (Holliman, Critten, et al., 2014; Holliman, Gutiérrez

Palma, et al., 2017; Kim & Petscher, 2016; Wood et al., 2009), this investigation of bilingual children's stress assignment and its relationship to reading contributes uniquely to a better understanding of the topic.

Sensitivity to Stress Cues

The present study showed that Korean-English bilingual children were found to rely on both morphological and orthographic cues as they assign lexical stress to multisyllabic English nonwords. First, in terms of morphological cues, the finding is consistent with prior studies that examined the participants' sensitivity to derivational suffixes as cues for lexical stress on English nonwords (Chung & Jarmulowicz, 2017; Wade-Woolley & Heggie, 2015). The current study extends to bilingual children previously reported findings among adult skilled readers of English who showed sensitivity to morphological cues to stress placement in both listening and reading tasks (Wade-Woolley & Heggie, 2015) as well as Mandarin-speaking adults who performed better than chance in both stress judgment and production tasks, exhibiting their sensitivity to stress cues based on different types of derivational suffixes (Chung & Jarmulowicz, 2017).

It is important to note that stress sensitivity to morphological cues were confirmed despite some differences in stress measures being used. In Wade-Woolley and Heggie's (2015) study, adult English speakers were asked to choose the sentence with the derived nonword that sounded better on the listening tasks while they were asked to read aloud the written nonword stems and derived nonwords on the reading task. Chung and Jarmulowicz (2017) adopted Wade-Woolly and Heggie's (2015) listening task for their stress judgement measure and Jarmulowicz's (2006) derived word production task (DWPT) for their stress production measure. In the present study, bilingual children were asked to circle one of the pre-segmented syllables that they prefer to assign the strongest stress rather than to read out the stimuli for recording. As discussed in the

methods section, the forced choice task was created in the present study to minimize potential issues—spondee (Wade-Woolley & Heggie, 2015) and re-syllabification (Chung & Jarmulowicz, 2017)—indicated in previous literature. Possibly due to the lack of lexical stress in Korean, one of the common errors in stress production is spondee response, in which approximately equal weights are given to every syllable in the words (No, 1998; Park, 2008). Moreover, pre-segmentation of syllables could control re-syllabification of multisyllabic nonwords stimuli so that the bilingual children can focus better on stress assignment.

In terms of orthographic cues, the finding also concurs with previous studies that demonstrated English-speaking adults' use of orthographic cues to assigning lexical stress to disyllabic nonwords (Arciuli & Cupples, 2006) and naming and lexical decision tasks using both real words and nonwords in English (Kelly et al., 1998). The stress assignment task in Arciuli and Cupples' (2006) study was very similar in format to the present study in which participants were asked to indicated lexical stress to nonwords by underlining the stress syllable. Moreover, prior studies that found sensitivity to orthographic cues examined English-speaking adults who were literate. The finding of the present study contributes to the literature by confirming that Korean-English bilingual children also showed sensitivity to orthographic cues as they assign lexical stress to English nonwords even with relatively limited exposure to the language.

The finding that bilingual children are sensitive to orthographic cues to English lexical stress further contributes to literature on computational models of word recognition that attempt to move beyond monosyllabic words. In rule-based, dual-route models of disyllabic word reading, suffixes play a critical role as cues to English lexical stress (Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001; Rastle & Coltheart, 2000). In contrast, the connectionist models of word recognition emphasize the importance of non-suffix, orthographic cues to stress assignment

(Perry et al., 2010; Ševa et al., 2009) and focus more on non-morphological, orthographic cues to lexical stress. In line with recent findings (Monaghan et al., 2016; Sparks, 2018), the current study also supports the connectionist frameworks by providing evidence for the importance of orthographic cues to lexical stress among Korean-English bilingual children.

Comparison of Different Types of Cues

Regarding the different degrees of sensitivity to the two different cues to stress assignment, the bilingual children performed significantly better in the stress assignment of the orthographic cues than that of morphological cues. This finding has confirmed the prediction based on the bilingual children's relatively limited exposure to morphological cues when compared to orthographic cues. Between grades 2-3 and grade 5, children are exposed to drastically increasing number of longer, morphologically-complex words with about 19,000 words per grade level (Kearns, 2015; Kearns et al., 2016; Toste, Williams, & Capin, 2017; Zhang, 2016). Better performance is expected with age, instruction, and more exposure to morphologically complex, multisyllabic words (Jarmulowicz, 2002). Therefore, considering the ages of the participants, the bilingual children who were in 3rd to 5th grades may not have fully developed their sensitivity to exponentially increasing numbers of morphological cues. On the other hand, however, the bilinguals may have been exposed more to non-morphological, orthographic word endings that signal stress assignment on disyllabic words.

Most recently, Sparks (2018) has made one of the first attempts to make a direct comparison between morphological and orthographic cues. Using lexical decision tasks among English-speaking adults, the researcher discovered that suffixes are not playing particularly unique roles as cues to lexical stress compared to non-suffix word endings. In other words, Sparks (2018) found empirical evidence for no significant differences between morphological

and orthographic cues to stress assignment in English disyllabic word reading. Although there are discrepancies between the findings due to different stimuli and tasks used, the present study affirms the importance of both types of cues to stress assignment in English.

In terms of the comparison between two subtypes of morphological cues, it was expected that Korean-English bilingual children would perform better with neutral derivational suffixes that nonneutral suffixes. A group of researchers has demonstrated that more difficulty or less accuracy was found with nonneutral suffixes than neutral suffixes in stress perception and production tasks among Korean learners of English even after training (Lee, 2007), in a stress production task among English-speaking children (Clin et al., 2009; Jarmulowicz, 2006) and Mandarin-speaking adults (Chung & Jarmulowicz, 2017). However, as a result of the present study, the bilingual children's performance was not influenced by suffix types. Although the prediction was not confirmed, this finding was in accord with stress judgment performance by Mandarin-speaking adults (Chung & Jarmulowicz, 2017) and aural suffix judgment task performed by English-speaking adults (Wade-Woolley & Heggie, 2015).

Despite the possible preference for assigning stress at the same location to the base and to the derived form with neutral suffixes, it could be nonneutral suffixes that tend to provide more predictable cues for stress assignment. Some studies have reported better performance with nonneutral suffixes than neutral counterparts in stress production and perception tasks among Korean learners of English (Park, 2011) as well as in written suffix judgment task among English-speaking adults (Wade-Woolley & Heggie, 2015). Thus, considering the mixed findings of different subtypes of morphological cues, the bilingual children's stress performance in the present study could not provide evidence for one particular aspect of interpretation.

Comparing the two subtypes of orthographic cues to lexical stress, the bilingual children did not show any statistically significant differences in their performance between trochaic and iambic stress patterns. This finding contradicts the prediction that the bilingual children would prefer trochaic stress pattern by assigning stress to the first syllable. Considering dominance of trochaic stress pattern in English, especially in disyllabic nouns taking up about 90% of the cases (Arciuli, 2017; Kelly et al., 1998), trochaic bias was assumed as a default strategy as the participants assign lexical stress to disyllabic nonwords (Ballard et al., 2012). However, no differences were found between the two stress patterns of orthographic cues. One possible explanation is that, as Kelly et al. (1998) indicated, due to such predominance of trochaic stress, "orthographic cues to stress are located in second rather than the first syllable of disyllabic words" (p. 822). From this perspective, the bilinguals could have focused on orthographic cues on the second syllable for iambic stress patterns. The current finding of no influence by orthographic cues subtypes could have supported mixed findings, in which the bilingual children could reliably use orthographic cues to iambic stress or assign trochaic stress by default when they do not locate such marked cues to iambic stress.

Relationship between Stress Cue Sensitivity and Reading Proficiency

In an attempt to disentangle prosody-reading relationship, the present study investigated how the bilingual children's stress cue sensitivity is related to their reading ability, such as oral language and pseudoword reading. Given the accumulating empirical evidence for the contribution of stress sensitivity to reading (e.g., Clin et al., 2009; Jarmulowicz et al., 2007; Kim & Petscher, 2016; Wade-Woolley & Heggie, 2016), significant correlation between the bilinguals' sensitivity to stress cues and reading performances were previously found. In the current study, however, no significant correlations were found among variables on stress cue

sensitivity and variables on reading, even after potential factors such as age, English vocabulary, and Korean vocabulary were controlled.

The lack of correlation between stress cue sensitivity and reading is not consistent with previous studies that have reported significant correlation between different measures of stress sensitivity with morphological cues and reading proficiency (Chung & Jarmulowicz, 2017; Clin et al., 2009; Jarmulowicz et al., 2007; Wade-Woolley & Heggie, 2015). According to Wade-Woolley and Heggie (2015), native English speakers' performance on reading task with both neutral and nonneutral suffixes, but not the listening task, was significantly correlated with their overall reading ability. More recently, Chung and Jarmulowicz (2017) found that Mandarin-speaking adults' performance on stress judgment in non-neutral derivation and stress production in neutral derivation made a contribution to word reading skills. For pseudoword decoding, stress production in neutral pseudoword derivation was the only predictor after controlling for working memory and English vocabulary. However, Chung and Jarmulowicz's (2017) finding is partly inconsistent with other previous studies that found stress production in nonneutral derivation as a significant predictor of general reading ability (Clin et al., 2009) and pseudoword reading (Jarmulowicz et al., 2007).

As for the orthographic cues to stress assignment, few studies have attempted to examine the relationship with reading proficiency. Although no study was found that investigated the correlation between stress sensitivity measures and reading measures at the lexical level, Sparks (2018) explored how orthographic cue sensitivity relates to reading comprehension in connected text among English-speaking adults and children. As a result, adults were found to rely on orthographic cues for reading comprehension while no significant relationship was found among children in Grades 3 to 6 (Sparks, 2018).

Such absence of the statistical significance in the present study can be speculatively explained in several ways. First, as mixed findings in previous studies demonstrate, the relationship between stress cue sensitivity and reading proficiency is affected by specific measures or type of cues used. Thus, it can be that the experimental design of the stress cues measures in the present study is tapping into particular aspect of stress cue sensitivity that may not necessarily be correlated with word and pseudoword reading proficiency. Second, considering the recent finding that demonstrated differences between adults and children (Sparks, 2018), another explanation may be that Korean-English bilingual children in grades 3 to 5 may not have developed their stress cue sensitivity at the level that is significantly correlated to their reading ability.

Limitations and Future Directions

There are several limitations that should be addressed in future research. First, it should be acknowledged that the number of syllables in morphological and orthographic cues are different: stimuli for morphological cues were three- or four-syllabic nonwords while stimuli for orthographic cues were disyllabic nonwords. This difference in the number of syllables may cause potential issues for direct comparison between performances on morphological and orthographic cues. One possibility to control the number of syllables is to compare suffix cues and non-suffix cues in disyllabic words or nonwords similar to the recent study by Sparks (2018). However, considering that derivational suffixes are added to the base words mostly with two or more syllables, it is almost inevitable to have an increased number of syllables once derivation is processed. Thus, another possibility is to measure both morphological and orthographic cues within the same task for future investigation. For instance, participants can be presented with disyllabic base stimuli for orthographic cues first, immediately followed by tasks

to measure the participants' sensitivity to morphological cues after derivation (Wade-Woolley & Heggie, 2015).

Second, given that different findings were associated with different formats—perception vs. production—of stress sensitivity tasks (Clin et al., 2009; Chung & Jarmulowicz, 2017; Jarmulowicz, 2006), the tasks used for stress cue sensitivity in the current study may have to be reconsidered. Although the forced choice task with circling the strongest pre-segmented syllable was chosen to minimize potential problems, a production task with recorded responses could be another good alternative so that participants can verbally assign lexical stress using different cues that may signal stress assignment. As noted in previous studies, task development for stress sensitivity has room for improvement in future studies (e.g., Arciuli, 2017; Holliman et al., 2014).

Finally, the present study can be extended to investigate Korean-English bilingual children's stress sensitivity and reading above word-level. For a more complete understanding of prosody-literacy relationship, future studies can investigate the contribution of stress sensitivity at and above word level to other reading measures such as multisyllabic word reading (Holliman, Mundy, et al., 2017) and/or reading comprehension ability in connected text (Sparks, 2018). Moreover, because the fundamental unit of prosody in Korean is accentual phrase, it would also be a meaningful step to examine relationship between Korean-English bilinguals' stress sensitivity and reading comprehension skills.

Despite the limitations mentioned above, the current study contributes to the accumulating empirical studies on stress sensitivity and reading. Using a newly adopted stress cue measures, the present study has made one of the first attempts to examine both morphological and orthographic cues in a single study. In addition, this study has also proved

potential of examining bilingual population with two different prosodic systems for their stress sensitivity and reading.

CHAPTER V

CONCLUSION

Over the past decade or so, literature has been expanding rapidly on the role of stress sensitivity to reading in English (e.g., Clin et al., 2009; Holliman et al., 2008; Mundy & Carroll, 2016). Some studies have found indirect contributions from stress sensitivity to word reading via several mediating factors such as phonological awareness (Clin et al., 2009; Kim & Petscher, 2016; Wood, 2006) and morphological awareness (Clin et al., 2009; Jarmulowicz et al., 2007; Kim & Petscher, 2016). Other recent findings revealed an additional, unique contribution of stress sensitivity to word reading independent of phonological awareness (Wade-Woolley & Heggie, 2016) as well as morphological awareness and vocabulary (Holliman, Gutiérrez Palma et al., 2017). Because English lexical stress is neither fixed nor marked in writing, accurate stress assignment is particularly important in English given its multisyllabic nature (Heggie, 2017; Holliman, Mundy, et al., 2017). However, little has been done to systematically review the accumulating literature or to examine bilingual speakers' stress sensitivity and its contribution to reading.

Of timely and critical importance, the current dissertation explored the relationship between lexical stress and reading in English. The dissertation chapters include three separate studies: (1) a systematic review on the relationship between lexical stress and reading in English, (2) one empirical study that examined Korean-English bilingual adults' sensitivity to different cues to lexical stress and its relation with reading, and (3) another empirical study that investigated Korean-English bilingual children's stress cue sensitivity and its contribution to reading.

Study 1 of the present dissertation showed that lexical stress sensitivity is significantly associated with word reading in English, confirming the three mediating variables—phonological awareness, morphological awareness, and vocabulary—along with the unique contribution of lexical stress to reading. Given the rapidly increasing number of empirical studies, the systematic literature review attempted to provide an up-to-date and thorough understanding of the extant studies in the field and, further, to lay a foundation for future investigations to disentangle the prosody-literacy relationships. Furthermore, a critical examination of different stress sensitivity measures suggests a more valid analysis of study designs for future research and a constructive discussion for pedagogical and/or clinical purposes.

Although English lexical stress is neither fixed nor marked in writing, there are two important cues to stress assignment in English—orthographic cues and morphological cues—which have been the focus of the two empirical studies. In the present dissertation, orthographic cues refer to probabilistic information of particular letter sequences in English that are associated with lexical stress pattern (Arciuli & Paul, 2012; Monaghan et al., 2016), whereas morphological cues refer to derivational suffixes in English that provide information for stress assignment (Chung & Jarmulowicz, 2017; Jarmulowicz et al., 2007; Wade-Woolley & Heggie, 2015). Considering the prosodic differences between English and Korean, the participants of the two empirical studies included the understudied population of Korean-English bilinguals whose prosodic system of L1 (Korean) differs greatly from that of L2 (English).

Study 2 revealed that Korean-English bilingual adults relied on both stress cues, and no statistically significant differences were found between the two cues. Study 2 also confirmed that Korean-English bilingual adults' stress cue sensitivity was related to their English reading. In

Study 3, Korean-English bilingual children also showed sensitivity to the two stress cues, but they performed better in orthographic cues to stress assignment task. However, Study 3 did not find any significant correlations among variables on stress cue sensitivity with those on reading.

The two studies contributed to the scarce literature on suprasegmental processing among bilingual readers by casting interesting open empirical questions of how sensitive these bilinguals are to English stress patterns, whether the bilinguals' stress sensitivity contributes to their reading ability, and whether their L1 prosodic system affects their L2 stress sensitivity. Furthermore, the inclusion of both adult and child groups of Korean-English bilinguals in two separate studies further broadened our understanding of the population.

The present dissertation on stress sensitivity and reading provides both research and practical implications. Theoretical frameworks of existing reading theories and computational reading models may benefit from potential empirical evidence on the contribution of stress sensitivity or processing to reading. Additionally, appropriate instruction or intervention can be provided to the bilingual readers by considering their L1 and L2 prosodic systems.

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APPENDIX A

CODING SHEET FOR THE SYSTEMATIC REVIEW

	Study 1	**Study 2**	**Study 3**
Publication date			
Participants			
Age			
L1			
L2			
Reading difficulties			
Methodology			
Sample size			
Design (Cross-sectional, correlational, …, or longitudinal)			
Statistical techniques			
Measures			
Stress sensitivity			
Other linguistic ability			
Reading ability			
Inter-rater reliability			
Findings			
Nature of the relationship (e.g., positive, negative, or no relationship)			
Mediator variable(s)			

APPENDIX B

STIMULI USED FOR PROBABILISTIC ORTHOGRAPHIC CUES

	Stimuli	*Word endings*	*% Trochaic (CELEX)*	*% Iambic (CELEX)*
P1	onsect	-ect		80
P2	fontage	-age	96.2	
1	dentose	-ose		72.22
2	plosure	-ure	64.44	
3	vegend	-end		77.78
4	masern	-ern	88.24	
5	baldron	-on	96.4	
6	hunstroke	-oke		55.56
7	hatchel	-el	84.15	
8	ampose	-ose		72.22
9	troduct	-uct		85.71
10	lenture	-ure	64.44	
11	curban	-an	90.73	
12	refend	-end		77.78
13	lanage	-age	96.2	
14	espect	-ect		80
15	dummon	-on	96.4	
16	savern	-ern	88.24	
17	brefect	-ect		80
18	rancel	-el	84.15	
19	feduct	-uct		85.71
20	nevoke	-oke		55.56
21	regan	-an	90.73	
22	fostpose	-ose		72.22
23	vorsage	-age	96.2	
24	hispel	-el	84.15	

25	aject	-ect		80
26	antend	-end		77.78
27	mucrose	-ose		72.22
28	viscern	-ern	88.24	
29	partel	-el	84.15	
30	setect	-ect		80

Note. P1 and P2 are items for practice. Items appear in the order of presentation.

APPENDIX C

STIMULI USED FOR MORPHOLOGICAL SUFFIX CUES

	Stimuli	*Stems*	*Suffixes*	*Suffix Type*
P1	fontageful	fontage	-ful	Neutral
P2	onsectation	setect	-tion	Nonneutral
1	vegedize	vegend	-ize	Neutral
2	savernity	savern	-ity	Nonneutral
3	dentosement	dentose	-ment	Neutral
4	amposer	ampose	-er	Neutral
5	lanagic	lanage	-ic	Nonneutral
6	brefectize	brefect	-ize	Neutral
7	rancellation	rancel	-tion	Nonneutral
8	lenturic	lenture	-ic	Nonneutral
9	plosureful	plosure	-ful	Neutral
10	baldronity	baldron	-ity	Nonneutral
11	hunstroker	hunstroke	-er	Neutral
12	troductize	troduct	-ize	Neutral
13	partellic	partel	-ic	Nonneutral
14	setectation	setect	-tion	Nonneutral
15	nevokement	nevoke	-ment	Neutral
16	curbanity	curban	-ity	Nonneutral
17	reganation	regan	-tion	Nonneutral
18	plosureful	plosure	-ful	Neutral
19	ajectize	aject	-ize	Neutral
20	viscernity	viscern	-ity	Nonneutral
21	hatchellic	hatchel	-ic	Nonneutral
22	refendment	refend	-ment	Neutral
23	masernation	masern	-tion	Nonneutral
24	especter	espect	-er	Neutral
25	feductic	feduct	-ic	Nonneutral

26	mucrosity	mucrose	-ity	Nonneutral
27	dummonful	dummon	-ful	Neutral
28	vorsagic	vorsage	-ic	Nonneutral
29	hispelment	hispel	-ment	Neutral
30	antender	antend	-er	Neutral

APPENDIX D

ORTHOGRAPHIC CUES TO STRESS ASSIGNMENT TEST

Which syllable would you put the strongest emphasis, or the primary stress?

Let's practice:

P1. onsect	on (sect)
P2. fontage	(fon) tage

Let's continue with the rest of the nonsense words:

1.	dentose	den tose
2.	plosure	plo sure
3.	vegend	ve gend
4.	masern	ma sern
5.	baldron	bal dron
6.	hunstroke	hun stroke
7.	hatchel	hat chel
8.	ampose	am pose
9.	troduct	tro duct
10.	lenture	len ture
11.	curban	cur ban

12.	refend	re fend
13.	lanage	la nage
14.	espect	e spect
15.	dummon	dum mon
16.	savern	sa vern
17.	brefect	bre fect
18.	rancel	ran cel
19.	feduct	fe duct
20.	nevoke	ne voke
21.	regan	re gan
22.	fostpose	fost pose
23.	vorsage	vor sage
24.	hispel	his pel
25.	aject	a ject
26.	antend	an tend
27.	mucrose	mu crose
28.	viscern	vis cern
29.	partel	par tel
30.	setect	se tect

APPENDIX E

MORPHOLOGICAL CUES TO STRESS ASSIGNMENT TEST

Which syllable would you put the strongest emphasis, or the primary stress?

Let's practice:

P1. fontageful	(fon) tage ful
P2. onsectation	on sec (ta) tion

Let's continue with the rest of the nonsense words:

1. vegendize	ve gen dize
2. savernity	sa ver ni ty
3. dentosement	den tose ment
4. amposer	am po ser
5. lanagic	la na gic
6. brefectize	bre fec tize
7. rancellation	ran cel la tion
8. lenturic	len tu ric
9. plosureful	plo sure ful
10. baldronity	bal dro ni ty
11. hunstroker	hun stro ker
12. troductize	tro duc tize

13. partellic	par tel lic
14. setectation	se tec ta tion
15. nevokement	ne voke ment
16. curbanity	cur ba ni ty
17. reganation	re ga na tion
18. fostposeful	fost pose ful
19. ajectize	a jec tize
20. viscernity	vis cer ni ty
21. hatchellic	hat chel lic
22. refendment	re fend ment
23. masernation	ma ser na tion
24. especter	e spec ter
25. feductic	fe duc tic
26. mucrosity	mu cro si ty
27. dummonful	dum mon ful
28. vorsagic	vor sa gic
29. hispelment	his pel ment
30. antender	an ten der

APPENDIX F

BILINGUAL PARENTS QUESTIONNAIRE

Please answer the following questions to the best of your knowledge.

[Parent Information]

Name: _____ Today's Date: _____

Relationship to child: _____ Nationality: _____

Parent Highest Education

1 = elementary school, 2 = middle school, 3 = high school, 4 = college, 5 = university degree, 6 = master's degree, 7 = doctoral degree

[Child Information]

Name: _____ Date of Birth: _____

Age: _____ Gender: _____

Name of School: _____ Class/Grade: _____

1. Please list all the languages your child knows **in order of dominance**:

_____

2. Please list all the languages your child knows **in order of acquisition** (your child's native language first):

_____

3. What is the language spoken **at home**?

_____

4. If more than two languages are spoken at home, what is the **percentage of the time** your child is currently and on average exposed to each language?

_____

4-1. If Korean is spoken at home, do you speak a regional dialect of Korean? If yes, please specify (e.g., Chungcheong dialect, Gyeongsang dialect, Jeolla dialect etc.).

---

5. Was your child born in the U.S.? (Please circle.)

Yes No

5-1. If not born in the U.S., where was he/she born?

_____

5-2. At what age did your child move to the U.S.?

_____

6. How long has your child lived in the U.S.? (Please circle.)

1-2 years 3-4 years 5-6 years 7-8 years 9-10 years

7. At what age did your child start to learn English?

_____

8. Does your child learn Korean? (Please circle.)

Yes No

8-1. If yes, how do your child learn Korean? (Please circle all the apply.)

a. Weekend or after-school Korean classes
b. Parents teach at home.
c. Reading Korean books
d. Watching Korean TV programs
e. Other methods. Please specify: _____

9. Please rate how frequently others identify your child as a non-native speaker based on his/her accent in Korean (on a scale of 0 to 10).

0 (never) 1 2 3 (half of the time) 4 5 6 (always)

10. Has your child had any vision problem, hearing impairment, language disability, or learning disability? If yes, please explain (including any corrections):

_____

[Child's Korean proficiency]

11. On a scale of 0 to 6, please select your child's level of proficiency in speaking Korean.

0 (none) 1 (very low) 2 (fair) 3 (adequate) 4 (good) 5 (excellent) 6 (perfect)

12. On a scale of 0 to 6, please select your child's level of proficiency in understanding Korean.

0 (none) 1 (very low) 2 (fair) 3 (adequate) 4 (good) 5 (excellent) 6 (perfect)

13. On a scale of 0 to 6, please select your child's level of proficiency in reading Korean.

0 (none) 1 (very low) 2 (fair) 3 (adequate) 4 (good) 5 (excellent) 6 (perfect)

[Child's English proficiency]

14. On a scale of 0 to 6, please select your child's level of proficiency in speaking English.

0 (none) 1 (very low) 2 (fair) 3 (adequate) 4 (good) 5 (excellent) 6 (perfect)

15. On a scale of 0 to 6, please select your child's level of proficiency in understanding English.

0 (none) 1 (very low) 2 (fair) 3 (adequate) 4 (good) 5 (excellent) 6 (perfect)

16. On a scale of 0 to 6, please select your child's level of proficiency in reading English.

0 (none) 1 (very low) 2 (fair) 3 (adequate) 4 (good) 5 (excellent) 6 (perfect)

[Parent's Korean proficiency]

17. On a scale of 0 to 6, please select your level of proficiency in speaking Korean.

0 (none) 1 (very low) 2 (fair) 3 (adequate) 4 (good) 5 (excellent) 6 (perfect)

18. On a scale of 0 to 6, please select your level of proficiency in understanding Korean.

0 (none) 1 (very low) 2 (fair) 3 (adequate) 4 (good) 5 (excellent) 6 (perfect)

19. On a scale of 0 to 6, please select your level of proficiency in reading Korean.

0 (none) 1 (very low) 2 (fair) 3 (adequate) 4 (good) 5 (excellent) 6 (perfect)

[Parent's English proficiency]

20. On a scale of 0 to 6, please select your level of proficiency in speaking English.

0 (none) 1 (very low) 2 (fair) 3 (adequate) 4 (good) 5 (excellent) 6 (perfect)

21. On a scale of 0 to 6, please select your level of proficiency in understanding English.

0 (none) 1 (very low) 2 (fair) 3 (adequate) 4 (good) 5 (excellent) 6 (perfect)

22. On a scale of 0 to 6, please select your level of proficiency in reading English.

0 (none) 1 (very low) 2 (fair) 3 (adequate) 4 (good) 5 (excellent) 6 (perfect)

Thank you for your participation!